1895
CARNEGIE LIBRARY
PITTSBURGH

PRESENTED BY

PUBLISHER

The Locomotive

OF

THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

VOL. XXXIV.

1223

PUBLISHED BY
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, CONN.
1922-1923.

INDEX TO VOL. XXXIV.—1922-1923

References Marked with a Star (*) are to Illustrated Articles.

*Accident to a Cooking Tank, An Unusual, _January, 1923_, 147.
Accidents Cripple 159,000 Horsepower of Ontario Hydro Units, _July, 1922_, 86.
*Air Receiver Explosions, _July, 1922_, 80.
*Bailey, C. B., A Piston Explosion, _April, 1923_, 177.
*Baumhart, Henry A., Death of, _April, 1922_, 55.
*Berry, E. Sidney, Elected Second Vice President and General Counsel, _April, 1922_, 53.
*Boiler Explosion, A Saw Mill, _October, 1922_, 98.
*Boiler Explosion at Bridgeport, Conn., _April, 1922_, 34.
*Boiler Explosion at a Louisiana Cotton Oil Mill, _January, 1923_, 130.
*Boiler Explosion at Greenwood, S. C., _October, 1923_, 226.
*Boiler Explosion, Clark and McCowan, Florence, S. C., _January, 1922_, 25.
*Boiler Explosion on Steamer Omar D. Conger, _July, 1922_, 78.
Boiler Explosions, Monthly List, March (Continued), April, May, June, 1921, _January_, 1922, 26, June (Continued), July, August, September, October 1921, _July, 1922_, 89; October (Continued), November, December, 1921, _October, 1922_, 121; December, 1921 (Continued), January, February, March, 1922, _January, 1923_, 150; March (Continued), April, 1922, _April, 1923_, 187; April (Continued), May, June, July, August, 1922, _July, 1923_, 216; August (Continued), September, October, November, December, 1922, _October, 1923_, 245; A Correction, _April, 1923_, 184.
Bonnet, A. E., Appointed Chief Inspector, Hartford Department, _July, 1923_, 215.
*Breaking of Crosshead Gib Caused Engine Accident, _January, 1922_, 2.
*Building up Shafts by Welding, By H. J. Vander Eb, _January, 1923_, 143.
Caught in the Separator; Awoke in the Air, A Letter, Extract from an Inspector's Report, It Wouldn't Fit, _April, 1922_, 58; Bullets Save the Day as Power Plant Stack Buckles, Music Travels From Air Into Boiler at Mill, Dyed-In-The-Wool P. A., _July, 1922_, 88; Boiler Gets Hot, Deserts the Scene, A Century Ago, More Yellow Peril, _October, 1922_, 120; Water in Boat Boilers, San Francisco Quake Victim Lived 17 Years in a Boiler, Grocer Cooks Tons of Spuds by Accident, _October, 1923_, 243.
*Coal Pile, Saving the, _July, 1922_, 67.
*Coates, L. L., A Novel Method of Removing a Concrete Stack, _July, 1923_, 206.
Connery, T. F., The Story of Mr. Herringbone and Mr. Clinker, _July, 1923_, 209.
*Corrosion of Iron and Steel, The, By C. L. Wright, _January, 1923_, 131.
*Corson, William R. C., Elected Vice President and Treasurer, _January, 1922_, 21.
*Diamond State Fibre Company, Bridgeport, Pa. Fly Wheel Accident, _July, 1923_, 194.

Central-Adult
Cop.

Discovery of Manganese Steel, The, *October, 1923*, 241.
Domestic Fuel Problem, The, *October, 1922*, 113.
Donts For The Boiler Room, A Dozen, *April, 1922*, Back Cover.
*Draft, The Significance of, with Some Notes on the Construction of Steel Smokestacks, *April, 1922*, 41.
Early Development of the Water Turbine, *October, 1922*, 109.
*Echo of The Park Central Hotel Explosion, An, *January, 1922*, 24.

Editorials:
  Coal Storage, *July, 1922*, 84.
  Engine Insurance, *January, 1923*, 148.
  Fatigue of Metals, *October, 1922*, 116.
  Importance of Fillets in Engine Shafts, *April, 1923*, 180.
  Miniature Boilers, *April, 1922*, 52.
  Safety Valves, *October, 1923*, 244.
  Water Gauges, *January, 1922*, 20.
*Electrical Insurance, Kenneth A. Reed, *July, 1923*, 195.
Electrical Machinery Insurance, *April, 1923*, 181.
*Engine Accident at Yale, Michigan, An, By J. P. Morrison, *October, 1923*, 239.
*Engine Accident, Breaking of Crosshead Gib Caused, *January 1922*, 2.
*Engine Wreck of Large Proportions, An, *July, 1922*, 66.
*Explosion, A Piston, by C. B. Bailey, *April, 1923*, 177.
Explosion of a Fireless Locomotive, *April, 1922*, 51.
*Explosion of a Ten Thousand Kilowatt Turbine, *April, 1923*, 162.
*Explosions, Air Receiver, *July, 1922*, 80.
Explosions, Boiler, See Boiler Explosions.
Explosions, Flywheel, See Flywheel Explosions.
*Fatigue of Metals, *October, 1922*, 99.
Fiber in Metals, *October, 1923*, 238.
*Fillets in Engine Shafts and Crank Pins, The Importance of, By E. Mason Parry, *April, 1923*, 163.
Fitch, F. M., Severs Connection With the Company, *January, 1923*, 149.
*Fitting of Keys in Crossheads and Flywheels, The, *April, 1922*, 36.
*Fly-Wheel Accident at Bridgeport, Pa., *July, 1923*, 194.
Fly Wheel Explosions, Regular List, 1921, *April, 1922*, 60.
Fly Wheel Explosions, Regular List, 1922, *April, 1923*, 186.
Fuel Problem, The Domestic, *October, 1922*, 113.
Fuels, Ignition Temperature of, *July, 1922*, 85.
Fuels, The Origin and Characteristics of, by C. L. Wright, *April, 1923*, 170.
*Gold Service Medals Awarded, *October, 1922*, 117.
Graham, A. Paul, Appointed Manager of Cleveland Department, *July, 1922*, 85.
*Graham, J. J., Elected Assistant Secretary, *April, 1922*, 53.
*Grendel Mills, Greenwood, S. C., Boiler Explosion at, *October, 1923*, 226.
Guy, Robert P., Appointed Assistant Chief Inspector, New York Branch, *July, 1923*, 215.
*Halsey, W. D., Safety Valves, *October, 1923*, 227.
*Historical Notes on the Early Locomotives in America, Some, *January, 1922*, 9.
Hugo, T. W., Death of, *April, 1923*, 182.
Ignition Temperature of Fuels, *July, 1922*, 85.

*Importance of Fillets in Engine Shafts and Crankpins, The, By E. Mason Parry, *April, 1923,* 163.
*Indianapolis Light & Heat Company, Indianapolis, Ind., Turbine Explosion, *April, 1923,* 162.
Inspection Statistics, 1921, *April 1922,* 59; 1922, *April 1923,* 185.
Instructions for Burning Soft Coal in the Home, Notice of Placard, *October, 1922,* 115.
*Keys in Crossheads and Flywheels, by E. Mason Parry, *April, 1922,* 36.
Laying Up The Furnace, On, *April, 1923,* 179.
Locomotive, Explosion of a Fireless, *April, 1922,* 51.
*Locomotives, A Notable Shipment of, *October, 1922,* 111.
*Locomotives in America, Some Historical Notes on the Early, *January, 1922,* 9.
*McMurray, Joseph, Completion of 50th Year of Continuous Service, *April, 1922,* 54.
*McNeill, J. H., Death of, *July, 1923,* 212.
*Mechanical Refrigeration and Refrigerants, *July, 1922,* 73.
Mechanical Refrigeration and Refrigerants, A Correction, *October, 1922,* 119.
*Medals, Gold Service, Awarded, *October, 1922,* 117.
*Metals, Fatigue of, *October, 1922,* 99.
*Middlebrook, Louis F., Elected Secretary, *January, 1922,* 22.
*Morrison, J. P., Engine Accident at Yale, Mich., *October, 1923,* 239.
Moving Picture Stars, A New Method of Rating, *July, 1923,* 211.
My Country, *July, 1922,* Back Cover.
New Method of Rating Moving Picture Stars, *July, 1923,* 211.
*Notable Shipment of Locomotives, A, *October, 1922,* 111.
*Novel Method of Removing a Concrete Stack, A, by L. L. Coates, *July, 1923,* 206.
Obituary Notices:
    *Henry A. Baumhart, *April, 1922,* 55.
    T. W. Hugo, *April, 1923,* 182.
    *J. H. McNeill, *July, 1923,* 212.
    Thomas E. Shears, *April, 1922,* 57.
    James G. Van Keuren, *October, 1922,* 118.
Ontario Hydro Units, Accidents Cripple 159,000 Horsepower of, *July, 1922,* 86.
Origin and Characteristics of Solid Fuels, by C. L. Wright, *April, 1923,* 170.
Over the Chief Inspector's Phone, *April, 1923,* 169.
*Park Central Hotel Explosion, An Echo of, *January, 1922,* 24.
Parry, E. M., Appointed Chief Inspector, New York Branch, *July, 1923,* 214.
*Parry, E. Mason,. The Importance of Fillets in Engine Shafts and Crank Pins, *April, 1923,* 163.
Personal:
    *Mr. E. Sidney Berry Elected Second Vice President and General Counsel, *April, 1922,* 53.
    Mr. A. E. Bonnet Appointed Chief Inspector Hartford Department, *July, 1923,* 215.
    * Mr. William R. C. Corson Elected Vice President and Treasurer, *January, 1922,* 21.

Mr. F. M. Fitch Severs Connection with Company, *January, 1923*, 149.
*Mr. J. J. Graham Elected Assistant Secretary, *April, 1922*, 53.
Mr. A. Paul Graham Appointed Manager of Cleveland Department, *July, 1922*, 85.
Mr. Robert P. Guy Appointed Assistant Chief Inspector, New York Branch, *July, 1923*, 215.
*Mr. Joseph McMurray, Completion of 50th Year of Continuous Service, *April, 1922*, 54.
*Mr. Louis F. Middlebrook Elected Secretary, *January, 1922*, 22.
Mr. E. Mason Parry Appointed Chief Inspector, New York Branch, *July, 1923*, 214.
Mr. Kenneth A. Reed Appointed Electrical Engineer, *April, 1923*, 182.
*Mr. Halsey Stevens Elected Assistant Secretary, *April, 1922*, 53.
*Piston Explosion, A, By C. B. Bailey, *April, 1923*, 177.
Reed, Kenneth A., Appointed Electrical Engineer, *April, 1923*, 182.
*Reed, Kenneth A., Electrical Insurance, *July, 1923*, 195.
*Refrigeration and Refrigerants, Mechanical, *July, 1922*, 73.
Refrigeration and Refrigerants, Mechanical, A Correction, *October, 1922*, 119.
*Rendering Tank, Unusual Accident to, *January, 1923*, 147.
*Safety Valves, By J. A. Snyder and W. D. Halsey, *October, 1923*, 227.
*Saving the Coal Pile, *July, 1922*, 67.
*Saw Mill Boiler Explosion, A, *October, 1922*, 98.
*Shafts, Building Up, By Welding, By H. J. Vander Eb, *January, 1923*, 143.
Shears, Thomas E., Death of, *April, 1922*, 57.
*Significance of Draft With Some Notes on the Construction of Steel Smokestacks, The, *April, 1922*, 41.
*Smokestacks, Some Notes on the Construction of Steel, *April, 1922*, 41.
*Snyder, J. A., Safety Valves, *October, 1923*, 227.
*Some Historical Notes on the Early Locomotives in America, *January, 1922*, 9.
Some Provider, *July, 1923*, 215.
*South Texas Cotton Oil Company, Eunice, La., Boiler Explosion at, *January, 1923*, 130.
*Stack, A Novel Method of Removing a Concrete, by L. L. Coates, *July, 1923*, 206.
*Staybolts, The Story of Two, *April, 1922*, 47.
*Steamer Omar D. Conger, Boiler Explosion on, *July, 1922*, 78.
Steel, Manganese, The Discovery of, *October, 1923*, 241.
*Stevens, Halsey, Elected Assistant Secretary, *April, 1922*, 53.
Story of Mr. Herringbone and Mr. Clinker, The, by T. F. Connery, *July, 1923*, 209.
*Story of Two Staybolts, The, *April, 1922*, 47.
Summary of Inspectors' Work for 1921, *April, 1922*, 59.
Summary of Inspectors' Work for 1922, *April, 1923*, 185.
*Turbine, Explosion of a Ten Thousand Kilowatt, *April, 1923*, 162.
Van Keuren, James G., Death of, *October, 1922*, 118.
*Vander Eb, H. J., Building Up Shafts by Welding, *January, 1923*, 143.
*Water Gauges and Their Care, *January, 1922*, 3.
Water Turbine, Early Development of the, *October, 1922*, 109.
*Welding, Building up Shafts by, By H. J. Vander Eb, *January, 1923*, 143.
*Wright, C. L., The Corrosion of Iron and Steel, *January, 1923*, 131.
Wright, C. L., The Origin and Characteristics of Solid Fuels, *April, 1923*, 170.

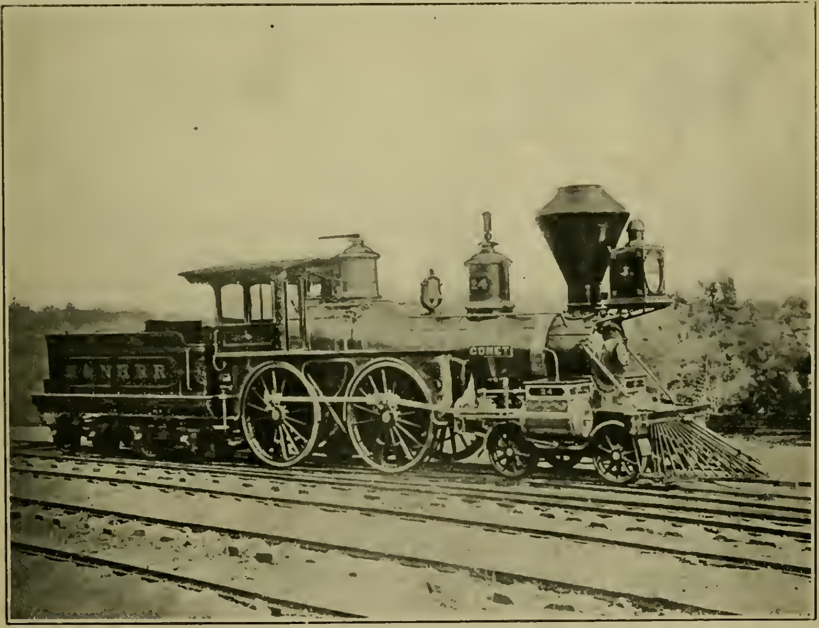
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

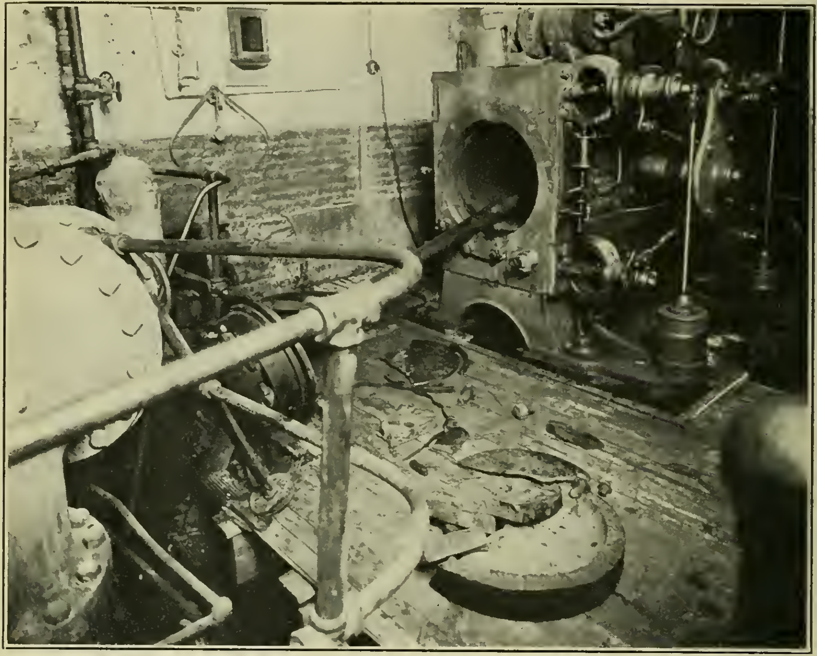
PUBLISHED QUARTERLY

VOL. XXXIV. HARTFORD, CONN., JANUARY, 1922. No. 1.

COPYRIGHT, 1922, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



THE "COMET."

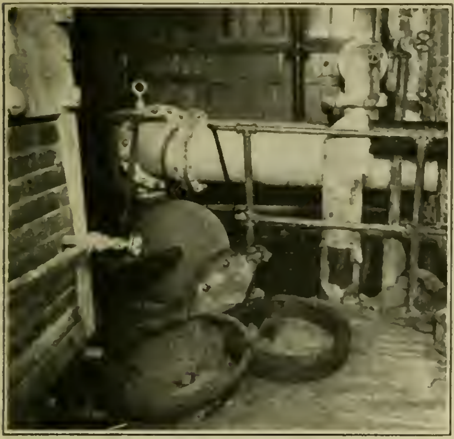


View of Wreck From Head End of Engine.

Breaking of Crosshead Gib Caused Engine Accident.

The sudden unexpectedness with which an engine breakdown takes place was rather graphically illustrated by an accident which recently took place in a New York factory. The engine which figured in this accident had been started about eight o'clock in the morning and about an hour later, just after the engineer had passed by the cylinder and had found the machine to be operating smoothly, there was a sudden snap, then a crash of breaking metal. Before anyone could determine what had happened the engine room was filled with steam and, as the throttle valve of the engine could not be reached, the stop valves on the boilers had to be closed. By the time this was accomplished, however, the hot steam which filled the engine room had opened several sprinkler heads and damage by water was added to that already done.

When admittance could again be had to the engine room, the cylinder-head was found blown off and lying on the floor, the piston and rod were almost completely out of the cylinder and damage seemed to prevail in all directions, as shown in the illustration above. The piston in its flight through the air struck an exhaust pipe from a turbine in the next room and so broke this pipe that a new one had to be installed. A motor driven condenser-pump also came in for a share of the damage, the shafts of both motor and pump being bent. Further examination of the piston showed that the follower-plate and the bull and piston-rings had been badly broken. A part of the damaged piston had evidently fallen into the head end exhaust-port so that motion of the exhaust-valve was prevented. As the flywheel of the engine carried the rest of the engine mechanism through several revolutions after the accident, this jamming of the exhaust-valve resulted in the breaking of the exhaust-valve-stem-arm.



View From Crank End.

An investigation was made to determine the cause of the accident and it was found that the gib which, with a cotter key, held the piston-rod in the cross head, had broken and, as this permitted the cotter or key to drop out, the piston-rod and the crosshead had become separated. Apparently this occurred shortly after the engine had passed the crank-end center so that the steam admitted to the cylinder at that time carried the piston and rod with terrific force toward the opposite end of the cylinder, breaking out the cylinder-head and causing the other damage that has been mentioned. What caused the gib to break has not been fully determined. The accident serves to illustrate however, the danger that is attendant upon the use of an engine however satisfactory its operation may appear.

Water Gauges and Their Care.

THE water gauge is a most essential part of the equipment of a boiler and, if properly installed and cared for, is as reliable as any other piece of apparatus about a power plant. Lack of care, however, may make it the most treacherous. We desire, therefore, to point out in this article some of the attention that this part of the boiler equipment requires.

The method of piping the water column, gauge glass and try cocks to a boiler, as approved by this company, is illustrated in Fig. 1.

The connections between the boiler and the water gauge should at all times be kept free and open. Upon coming on duty and several times while on duty the fireman should blow down the water gauge piping to preclude any possibility of a stoppage in the pipe such as might be caused by scale entering it from the boiler. To do this the cocks or valves at the top (No. 2) and the bottom (No. 3) of the gauge glass are closed and the mud valve (No. 1) in the water column drain is opened and permitted to blow steam and water for a minute or two so as to thoroughly flush out the water column and the pipe connections to the boiler. After this has been done and valves 2 and 3 have again been opened, attention should be turned to the gauge glass itself. The pet cock (No. 4) should first be opened and steam and water allowed to blow through it freely for a short time. Then the top valve, No. 2, is closed to let water only pass out through the pet cock, thereby showing a clear pas-

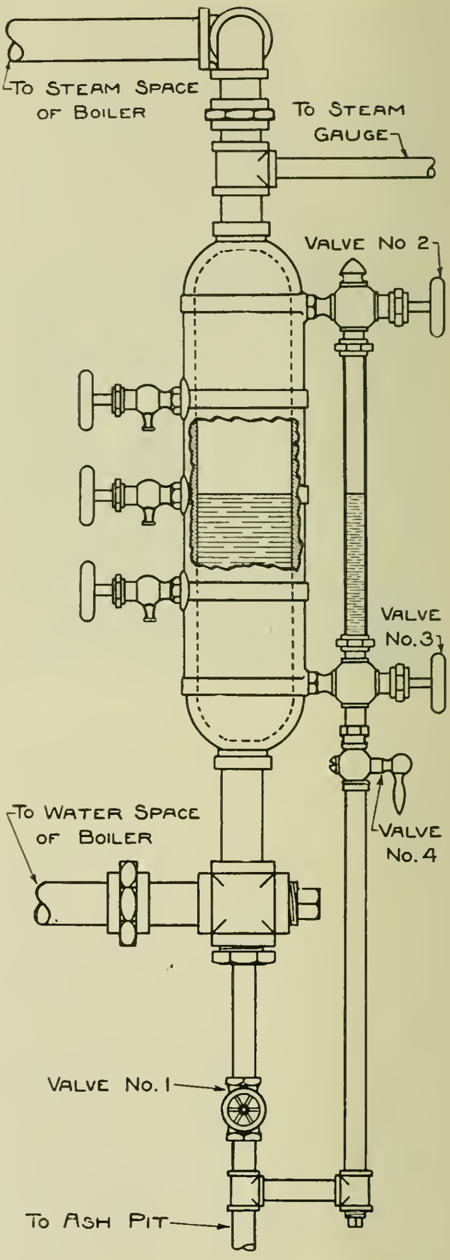


Fig. 1.

sage to the bottom of the gauge. By closing valve 3 and opening valve 2 the passage of steam only will indicate that the top connection is clear. When this manipulation of the valves has been accomplished, the pet cock is closed and the top and bottom gauge cocks opened. If the connections are clear, the water will rise at once to the proper level where it will have a gentle up and down motion in the gauge glass. On the other hand, if the bottom connection were obstructed in any way the water would not return quickly to its proper level. If, at the same time, the top connection were open, steam would enter through it and by condensing in the glass would give a slowly rising water level. A faulty reading would also be given if the top valve were left closed after the procedure of blowing down. The vapor left in the glass would slowly condense, thereby forming a vacuum and the water, entering through the lower connection and forced by the pressure in the boiler, would rise until the glass was completely filled.

The piping for the water column and gauge should be limited to that shown in the sketch. Sometimes a connection for steam to supply the injector or other appliance is made in the pipe leading from the water column to the steam space in the boiler. This should never be done for when steam flows through such a pipe connection the pressure is reduced above the water level in the gauge glass, the water rises and a false indication is given.

When doubt exists as to the reading of the gauge or in case of breakage of the gauge glass, the try cocks may be used. The glass should be replaced or put into proper operation as soon as possible as it is a continuous indicator of the water level in the boiler and, obviously, is more convenient than the try cocks.

Low water has been the cause of many disastrous boiler accidents. As an illustration, Fig. 2 on pg. 6, shows the boiler of a locomotive where it landed after an explosion that was due to low water. The following extract from the Ninth Annual Report of the Chief Inspector of Bureau of Locomotive Inspection to the Interstate Commerce Commission and relating to this accident contains several points of interest:

"A patch 14 inches long and 42 inches wide had been applied in the front end of the crown sheet, riveted to flue sheet with back and side seams autogenously welded. The longitudinal weld in the left seam was of poor quality and evidently caused the initial rupture. The top water-glass cock was found closed at the time of the accident. The stem was found bent so that it could not be opened without the aid of a wrench and the handle had been broken off. Too much care can not be given to the condition of the water level indicating appliance on the locomotive boiler, and this accident illustrates the importance of testing and knowing at all times that they are in proper condition."

Courtesy, I. C. C. Fig. 2.

Gauge glasses frequently break and must be replaced. This is an operation that requires much care and, in this regard, we believe that no better information can be found than that given in an article entitled "Water Gauge Glasses," by Charles S. Blake, now president of this company, which was published in the January 1912 issue of The Locomotive. Because of the valuable information contained in that article, we are reprinting it herewith.

"The breaking of water gauge glasses is of such frequent occurrence, that a few words concerning their attachment and use may, if heeded, prevent some accident and possibly personal injuries, besides the annoyance of frequent replacements.

"The use of a visible gauge as an auxiliary to indicate height of water in a steam generator has become a recognized necessity, and is required by authorities exercising jurisdiction over boilers. One municipality at least places such value on their use as to recognize a second gauge glass as a substitute for the gauge cocks and does not require the latter when two gauge glasses are properly affixed.

"The ordinary or customary gauge glass in a plain cylindrical tube, ranging for ordinary use from ⅝ inches to ⅞ inches in diameter and of a length to suit the varying conditions and types of boilers. These diameters are outside dimensions. They vary slightly, but as the glasses are set in compressible washers such variation is not detrimental. They are made in this country and abroad, but those of Scotch glass are considered the best. The very nature of the material makes it brittle, and aside from its brittleness it possesses other peculiar qualities that when known should cause engineers and firemen to handle these glasses with more than ordinary care. A novice in examining a gauge glass will almost immediately pronounce it defective, because of the fine lines running lengthwise in it; but such lines are usually indicative of good quality and are more pronounced in the Scotch glass than in the American.

"All glasses are keenly susceptible to surface abrasions, even so minute as to be unobservable. If one receives the slightest scratch inside or out, it should not be used, and in handling or keeping them in stock, no metal of any nature should be allowed to come in contact with them. They are particularly liable to break if iron or steel touches them, and so should never be laid down even temporarily with tools, as is frequently done in preparation for a renewal.

"It may sometimes be thought desirable to clean an old glass when it has every appearance of being whole and sound. In such an event, waste or a cleaning cloth should be used and should be pushed through the bore by means of a wooden stick small enough to pass without force. As a rule, however, the price of gauge glasses is too low to bother with the cleaning of old ones, and if one shows any deterioration at its ends, it should be discarded in any case.

"In the prevention of accidents, not the least measure of importance is to have the receptacles for the glass properly attached before trying to insert it. Every one who has had occasion to put in gauge glasses is familiar with the so-called gauge glass "cocks," which form its support. They are not cocks, however, but valves. In some of the special types of water glass connections, cocks are used as a means of closing, but the percentage in use is very small. The valves are fitted in various ways,— sometimes directly into the boilerplate, more commonly into water columns of cast iron or those improvised from ordinary pipe and fittings. The openings to receive the valves should be parallel and threaded an equal depth, so that when the valves themselves are screwed in position the sockets in them for the reception of the glass will be in a direct line. Both top and bottom valves have these sockets bored out to a considerable depth. If the eye cannot detect the valves out of line, the glass should be inserted in them, to more clearly determine whether the valves are in true alignment or not. The glass should be cut to the greatest length that will permit its insertion, one cock or valve usually admitting it to a greater depth than the other.

"In the selection of a glass, one should be used that will freely enter the valve receptacle and leave a little space around it when in position, and the nuts or glands for compressing the gaskets should be large enough not to touch the glass when screwed up. Only fresh, pure rubber gaskets or washers cut by machine, uniform in size, and prepared for such purpose should be used. After inserting the glass in the valves, it should be shifted so the washers will be at an equal distance from its ends. This is very important, for the writer in his investigations of boiler explosions has found two instances where a washer softened by the heat, under pressure of the gland, has squeezed out under the glass and closed the opening, thus permitting a false indication of the water level. [*Editor's Note — Fig. 3 illustrates such an obstruction which recently came to the attention of the Bureau of Locomotive Inspection of the Interstate Commerce Commission.*] The glands should first be screwed by hand, each a little in turn until they can no longer be moved by the fingers. Then a small wrench may be used on them alternately, until the glass is firm in the packing. Care should be taken that the glass does not shift in its vertical position, during this operation.

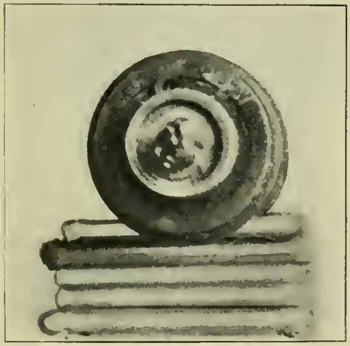


Fig. 3.

"It may be needless to say that in renewing a glass with pressure on the boiler, the valves should be closed tight and the drip opened to release the pressure before attempting the removal. When a new glass has been put in, if the valves are not provided with means for opening at a distance, a board or sheet-iron shield large enough to protect one's head should be held between the face and the glass, and the valves then opened very easily and slowly to their full extent. When they are open, it is advisable to retire with the shield in front of the face to observe at a distance whether there are any leaks, and if any appear, to return to the glass with the face still protected, shut off the valves, release the pressure through the drip, and then tighten the nuts. Never under any circumstances attempt to tighten them with pressure on the glass.

"In the writer's experience, he has found it possible to make the joints tight by only a slight pressure of the wrench and whenever he has found gauge valves out of alignment he has trued them up. As a result of this practice during considerable experience with marine and stationary boilers never has he had a glass break under pressure.

" If gauge glasses are properly handled and used they will withstand great extremes of temperature, although it is well to guard against drafts from outside in cold weather. In the selection of glasses it is not necessary to pick out the ones with the heaviest walls, for those with slightly lighter walls are as strong and will last as long as the thicker ones.

" The great precaution is to keep the surface from being scratched, for, as every engineer knows it requires but the slightest breaking of the skin of the glass in a circumferential way to cause it to almost fall apart. The peculiar phenomenon of the glass breaking which has lain next to iron or steel has never been explained to me, but I have a number of times as an experiment, taken a glass, run a smooth rod of iron through it and put it away. Sooner or later it has been found shattered in many pieces. My first observation of this phenomenon was when I placed a glass on a shelf in an engine room with a large pocket knife against it to keep it from rolling off. The next day I found the glass all in pieces but the pieces in their respective positions, showing that the breakage was not from violence else the pieces would have been scattered."

Some Historical Notes on the Early Locomotives in America.

ALMOST every eastern section of the United States has its story relating to the first railroad in the country and many lay claim to the honor of having had the pioneer within their territory. When limited by certain qualifications many of these claims are justified and this has given rise to considerable misunderstanding as to their real worth. We have recently had called to our attention a valuable old book which sheds a vast amount of light on the history of the first steam locomotives in this country and, believing that our readers would find it interesting to learn somewhat of this history in a condensed form, we shall endeavor to present a few of the facts as we have learned them from this and other sources.

The book from which we have obtained a great deal of our information is " The History of the First Locomotives in America " by Wm. H. Brown, published by D. Appleton and Company of New York in 1871. The author was not a railroad man himself but, from the evidence presented in one chapter of the book, appears to have engaged extensively in the making of silhouette portraits, his stock in trade being a sheet of black paper, a pair of scissors and his own skill in the work. His interest in the history of locomotives was probably aroused by his having made an excellent profile likeness of the locomotive "De Witt Clinton" and train upon which he was a passenger on its first official trip in 1831. All the essential facts that are given in the book are well substantiated by letters from railroad officials of the roads mentioned.

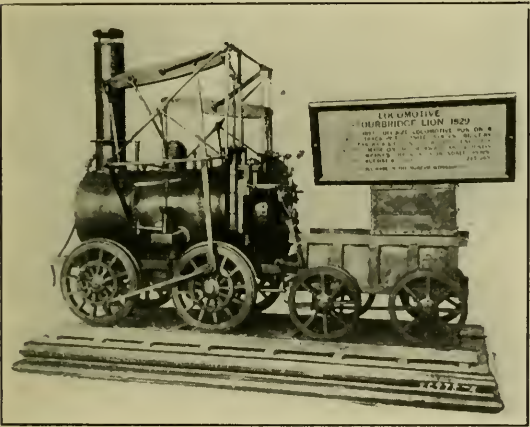
Before taking up the history of locomotives in America the author devoted considerable space to the beginnings of steam locomotion in England and France and for the information of our readers we shall record briefly a few of these facts.

The first steam locomotive of which there is any record was not designed for use on tracks but was a road wagon and was built by a Frenchman, named Cugnot, in 1769. While running at the speed of three miles per hour, it upset and was seized by the authorities as it was believed to be dangerous. What an example for the authorities of today! Cugnot was followed in 1784 by an Englishman, William Murdock by name, who built a model of a three wheeled road locomotive. These two pioneers were followed at varying intervals by others whose ideas also were at great variance. Robert Trevithick, an Englishman, was one of the pioneers and in 1804 built a steam locomotive to operate upon the tram roads or railroads which were in wide use in the country for horse drawn vehicles. None of these early inventors, however, reached more than the experimental stage with their machines and it was not until George Stephenson as chief engineer of a railroad near Hatton, Durham, England, operated five of his locomotives on the 18th of November, 1822, that the public believed that the steam locomotive would be developed to any extent. It is interesting to note that at that time it was generally believed that the future development of the railroads lay in the scheme of using stationary engines and cables to draw the trains of cars. There was great controversy in this regard among the Directors of the Liverpool and Manchester Railroad and to settle the question once and for all a competitive demonstration of several locomotives was arranged with a prize of £500 for the winner. Four locomotives were entered for the contest which was won by Stephenson's "Rocket." The date of this contest was October 6, 1829.

Work on the first railroad, not for steam, however, that was built in the United States was begun in 1826 and completed in 1827. The road extended from the granite quarries of Quincy, Mass., to the Neponset River, a distance of three miles. At about the same time — the work was started in January, 1827, and completed in May of the same year — the second road was built at the coal mines near

Mauch Chunk, Pennsylvania. This road was on an inclined plane and the famous Mauch Chunk Switchback is undoubtedly its direct descendant. In 1828 the Delaware and Hudson Canal Company, the Baltimore and Ohio Railroad, and the South Carolina Railroad began the construction of their roads.

Soon after this the trials of the Liverpool and Manchester Railroad were conducted and they naturally attracted the attention of the early experimenters in this country. Mr. Horatio Allen of the Delaware and Hudson Canal Company and Mr. E. L. Miller of Charleston, South Carolina, were two engineers who made this trip and Mr. Allen, while in England, purchased three locomotives for his company. The first of these, "The Stourbridge Lion," arrived at New York City about the middle of May, 1829. It was later shipped to Honesdale, Pennsylvania, and was given its first trial trip at that place on August 8th, 1829, on the tracks of the Delaware and Hudson Canal Company. This date we believe marks the first operation of a full size steam locomotive on a railroad in the United States. An illustration of a model of "The Stourbridge Lion" that is now in the possession of the National Museum in Washington, D. C., is given herewith.



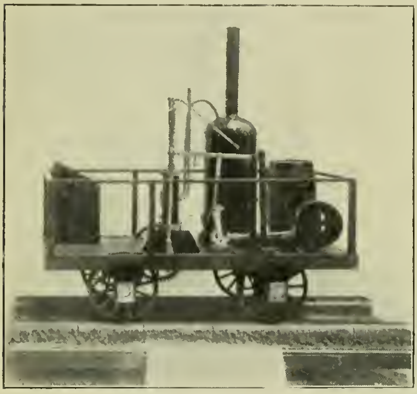
THE "STOURBRIDGE LION."

International

The trial trip of this first locomotive extended over about three miles at what a witness said was "a good speed" but it was the first and the last trip that this pioneer ever made. The roadbed was found too light for the work imposed on it and "The Stourbridge Lion" was stored in a shed, there to be gradually dismantled. The boiler was subsequently used in a foundry at Carbondale where it was in service for at least twenty years.

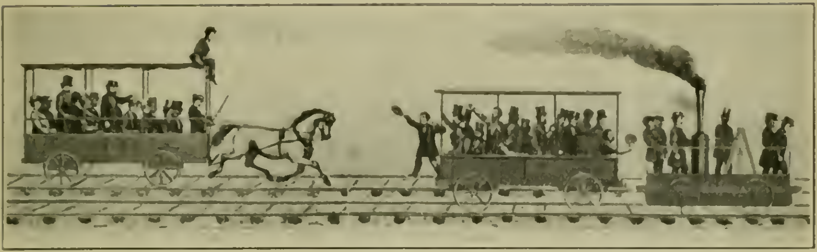
The official opening of the Baltimore and Ohio Railroad is reported as having taken place on May 24th, 1830. The first train of cars carried a number of the railroad and city officials and was drawn by a horse. A number of subsequent trial trips were made and shortly after a schedule was posted of the arrival and departure of trains between Pratt Street in Baltimore and Ellicott's Mills, Maryland.

The attention of the Baltimore and Ohio Railroad officials was soon directed toward the steam locomotive but it was believed that the road, having been constructed with short radius turns, was ruined for the steam locomotive. This, however, was not the opinion of that staunch American philanthropist, Peter Cooper, the founder of The Cooper Institute in New York City. He built a locomotive, a diminutive affair, to be sure, but nevertheless a locomotive, and from all that we can learn it was the first American built steam locomotive to draw a car with passengers. This engine was known as the "Tom Thumb" and was constructed in 1829. It later was altered somewhat and on the 28th of August, 1830, made its first trip thereby disproving the contention that steam locomotives could not be used on the road. On this trip, the distance of thirteen miles was covered in fifty-seven minutes actual running time. A model of the "Tom Thumb" is in the National Museum at Washington and the illustration above is from a photograph of this model.



THE "TOM THUMB."

A trial of speed was later held between a horse drawn car and one pulled by Cooper's "Tom Thumb." A reproduction of an interesting old sketch depicting this contest is given on page 13. The locomotive at first drew away from the horse drawn car and undoubtedly would have won the trial had it not met with a most unfortunate accident. The furnace of the boiler was operated with forced draft and the fan for doing this was driven by a belt. During the race this belt slipped off the pulleys and before it could be replaced the steam pressure had fallen so low that the horse had gained too great an advantage to overcome. While we find no further record of its operations it evidently had made a favorable impression on the officials of the road for in 1831 they offered a



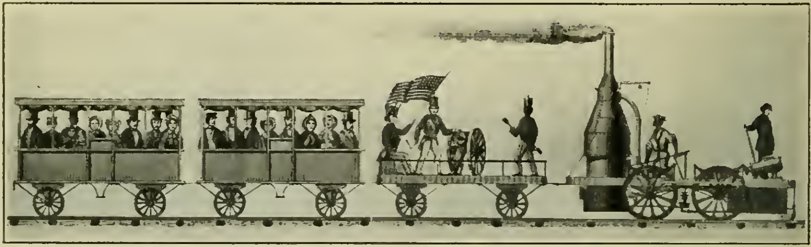
Race Between Horse Drawn Car and the "Tom Thumb."

premium for the best locomotive of American manufacture which should comply with certain stated specifications. An engine built by Phineas Davis in York, Pa., was the only one to come up to the specifications and to pass the test.

While these experiments were being carried on, another road was under construction in the South. On December 19th, 1827, a charter had been granted for The South Carolina Railroad, to operate between Charleston and Hamburg, a distance of one hundred and thirty-six miles. The organizers of this road engaged Mr. Horatio Allen, of whom mention has been made, as its chief engineer and in his report at the first meeting of the stockholders he recommended that the road be constructed for steam locomotives. The Honorable Thomas Bennett offered a resolution to that effect which was adopted by a unanimous vote. It thus appears that, while the Delaware & Hudson and the Baltimore & Ohio railroads were converted to steam power, the South Carolina Railroad was the first to adopt the steam locomotive from the very beginning.

Mr. E. L. Miller of Charleston contracted to build the first locomotive for this road and work was started in the summer of 1830 at the West Point Foundry in New York City. This locomotive "The Best Friend" was completed in the fall of the same year and the first trial trip was made on November 2, 1830. Its first excursion trip with passengers and with Nicholas W. Darrell at the throttle was made on the fifteenth of January, 1831. The sketch on page 14 shows "The Best Friend" and a train of cars as they are supposed to have appeared on this occasion. It is amusing now, but in all probability it was not then, to note the "defense car" and the sweep at the front of the locomotive to remove obstructions.

The trials of the early experimenters were many. We note that on the first trial trip of "The Best Friend" the driving wheels were found of improper construction to adequately withstand the lateral



"THE BEST FRIEND."

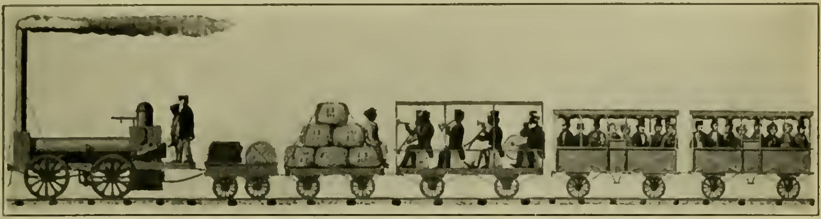
pressure imposed upon them when rounding a curve and had to be replaced. On the fourteenth and fifteenth of December, 1830, the locomotive was put through another set of trial trips and developed a speed of from sixteen to twenty-one miles per hour while pulling a train of four cars in which there were forty odd passengers. Running alone, the locomotive made from thirty to thirty-five miles per hour.

Apparently "The Best Friend" continued in service until June, 1831, when an accident occurred which we cannot fail to record in the pages of THE LOCOMOTIVE. On the seventeenth day of the month the boiler of the locomotive exploded, marking the first accident of a railroad locomotive boiler in the United States. The explosion was recorded in the *Charleston Courier* for June 18th, 1831, as follows: —

> "Saturday Morning, June 18, 1831
>
> "The locomotive 'Best Friend' started yesterday morning to meet the lumber-cars at the Forks of the Road, and, while turning on the revolving platform, the steam was suffered to accumulate by the negligence of the fireman, a negro, who, pressing on the safety-valve, prevented the surplus steam from escaping, by which means the boiler burst at the bottom, was forced inward, and injured Mr. Darrell, the engineer, and two negroes. The one had his thigh broken, and the other received a severe cut in the face and a slight one in the flesh part of the breast. Mr. Darrell was scalded from the shoulder blade down his back. The boiler was thrown to the distance of twenty-five feet. None of the persons are dangerously injured except the negro, who had his thigh broken. The accident occurred in consequence of the negro holding down the safety-valve while Mr. Darrell, the engineer, was assisting to arrange the lumber-cars, and thereby not permitting the necessary escape of steam above the pressure the engine was allowed to carry."

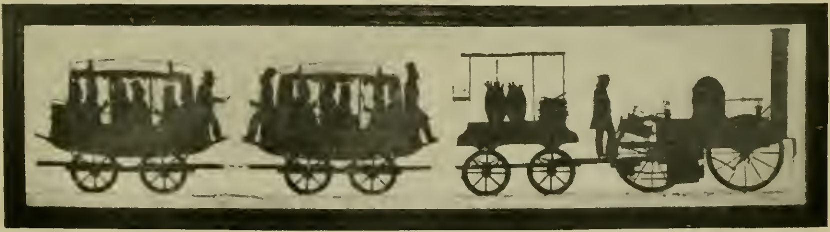
Apparently a bad precedent was set in this accident for we have since heard of many boiler explosions having strikingly similar characteristics and causes. After the accident the "Best Friend" was rebuilt and was again put into service but under the name of the "Phenix" the choice of which seems very fitting.

The equipment of the South Carolina Railroad was added to by the arrival of a second locomotive, the "West Point," (on February 28, 1831) a sketch of which, with a train of cars, is reproduced herewith. The car carrying the bales of cotton was placed in the train for a particular purpose. An article in the Charleston Courier for August 1, 1831, states, in part, that "The safety has been insured by the introduction of the barrier car —." Nothing is said of the passenger shown in this car as being part of the "barrier." The article continues by saying, "The new locomotive worked admirably, and the safety valve, being out of the reach of any person but the engineer, will contribute to the prevention of accidents in the future." This may have been so, although it does not appear very evident from the sketches.



THE "WEST POINT."

In the history of the early locomotives of this country probably none is surrounded with more romance than the famous "De Witt Clinton" now in the possession of The New York Central Railroad. As we have mentioned before, Mr. Wm. H. Brown, made a silhouette of this locomotive and train and this is now in the possession of The Connecticut Historical Society at Hartford, Conn. We have had a photograph made of this historical illustration and reproduce it herewith. Mr. Brown states that it was made on the ninth of August, 1831, at Albany, N. Y., while the "De Witt Clinton" and train were standing ready for the first excursion trip over the Mohawk and Hud-



THE "DE WITT CLINTON."

son Railroad which extended from Albany to Schenectady, N. Y. Several trial trips, the author states, had been made previous to this date. The silhouette is reproduced in The History of the First Locomotives in America, and beneath it appears the following: —

> "The locomotive 'De Witt Clinton' was ordered by John B. Jervis chief engineer of the Mohawk and Hudson Railroad, and was the third locomotive built in America for actual service upon a railroad. The machine was made at the West Point Foundery Works in New York, taken to Albany in the latter part of June, 1831, and was put upon the road and run by David Matthew. The first experimental trial-trip was made on the 5th of July, and others at different times during that month. The first excursion-trip, with a train of passenger-cars, was made from Albany to Schenectady on August 9, 1831, on which occasion the author of this History of the Early Locomotives in America rode in one of the cars (only the first two are represented above), and before the train started made the sketch as it appears above, which was pronounced a truthful representation of the locomotive, tender, and the first two of the number of cars in the train, and correct likenesses of the engineer and passengers represented in the cars. Some of them are yet living, as their letters in this work will show. The picture was cut out of black paper with a pair of scissors, a peculiar art with which the author was gifted from his earliest boyhood. The original picture was presented by the author to the Connecticut Historical Society; it was about six feet in length, and is yet preserved by the society and highly valued for its antiquity and truthfulness. The names of the engineer and passengers are as follows, commencing at the engine: David Matthew, Engineer; first car, Erastus Corning, Esq., Mr. Lansing, ex-Governor Yates, J. J. Boyd, Esq., Thurlow Weed, Esq., Mr. John Miller, Mr. Van Zant, Billy Winne, penny postman; second car, John Townsend, Esq., Major Meigs, old Hays, High-Constable of New York, Mr. Dudley, Jos. Alexander, of the Commercial Bank, Lewis Benedict, Esq., and J. J. Degraft. These likenesses were all readily recognized at the time they were taken — forty years ago. The outside seats were for the drivers when these cars had been drawn by horse-power, but on this occasion were occupied by the excursionists."

Mr. Brown in his book prints a letter from a Mr. David Matthew who was the engineer on the "De Witt Clinton" on this first excursion trip. This letter we have copied for the historical facts contained in it.

"Philadelphia, February 13, 1860.

"William H. Brown, Esq.—

"Dear Sir: Yours of January 17th is at hand. Having been absent, my reply has been delayed until this date. I will endeavor to answer your several questions as correctly as I possibly can, in the absence of records.

"First. I did run the 'De Witt Clinton' on the 9th day of August, 1831, and every day that it run from the 2d day of July, when first put on the road, to December 1, 1831.

"Second. There was no English-built engine upon the road, until the 'Robert Fulton,' made by Stephenson, arrived, which was about the last of August. About the middle of September it was tried on the road, and commenced regular trips soon after. On the excursion-trip in September, the Fulton was assigned to haul the train, but something got wrong about the supply-pipe, and my engine, the 'De Witt Clinton,' was called out for that duty, and did it well.

"Third. I did know John Hampson and Adam Robinson. John Hampson was my assistant. He left West Point Foundery with me, and when the 'Robert Fulton' arrived and was placed on the road, he took her to run. Adam Robinson became my fireman on the 'De Witt Clinton' when we began to make regular trips.

"When the 'John Bull' came out, nearly a year afterwards, John Hampson took her to run. Both of these men are now dead. John Hampson left the Mohawk and Hudson Railroad early in 1832. He brought the second engine from New York that was run on the Germantown and Philadelphia Railroad. He next took the 'Davy Crocket' to the Saratoga Railroad; then took charge of the Camden and Amboy Railroad machine-shops at Bordentown. Thence he went to the New Orleans and Carrollton Railroad, on a salary of five thousand dollars per year, where he remained several years.

"Adam Robinson was killed by accident on a railroad.

"Will you please procure and send to me one of the drawings, or photographs, from the original picture you took in Albany, of the old 'De Witt Clinton' and train of cars? I saw the original picture at your room in Albany, and was forcibly struck by the accuracy of your likeness to the old machine, the cars, and the passengers, several of whom I knew well.

"If I can give you any other information, write me at once, and I will try to be more prompt in my reply.

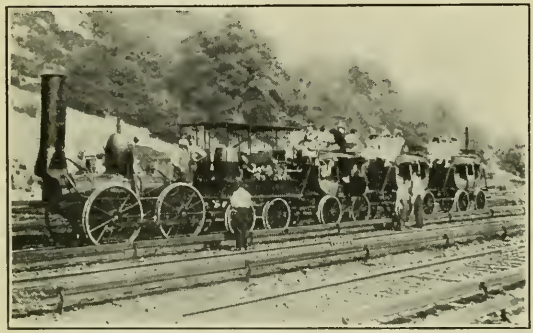
"Respectfully yours,
"David Matthew,
"205 Pear Street, Philadelphia."

The "De Witt Clinton" was not the only locomotive of the Mohawk & Hudson Railroad for the "Robert Fulton" built by Stephenson in England was also part of the equipment. This engine arrived in America sometime in August and it was scheduled to be used at the official opening of the road on September 24, 1831. From the following article which appeared in the *Albany Argus* for September 26, of that year we find, however, that the honor of drawing the train on the official opening day went to the American locomotive.

"Railroad Excursion. — On Saturday, September 24th, a numerous company, at the request of the president and directors of the Mohawk and Hudson Railroad Company, enjoyed a very gratifying ride upon the road. The company consisted of the Governor, Lieutenant-Governor, members of the Senate, now in session as a Court of Errors, our Senators in Congress, the Chancellor and Judges of the Supreme and District Courts, State officers, the president of the Board of Assistants and members of the Common Council of the city of New York, the Mayor, Recorder, and corporation of the city, and several citizens of New York, Albany, and Schenectady.

"Owing to a defect on one of the supply-pipes of the English locomotive, that powerful engine was not brought into service, and the party, having been delayed in consequence, did not leave the head of Lydius Street until nearly twelve o'clock. They then started with a train of ten cars, three drawn by the American Locomotive 'De Witt Clinton,' and seven by a single horse each. The appearance of this fine cavalcade, if it may be so called, was highly imposing. The trip was performed by the locomotive in forty-six minutes, and by the cars drawn by horses in about an hour and a quarter. From the head of the plane, about a quarter of a mile from Schenectady, the company were conveyed in carriages to Davis's Hotel, where they were joined by several citizens of Schenectady, and partook of a dinner that reflected credit upon the proprietor of that well-known establishment. Among the toasts offered was one which has been verified to the letter, viz.: 'The Buffalo Railroad — may we soon breakfast in Utica, dine in Rochester, and sup with our friends on Lake Erie!' After dinner the company repaired to the head of the plane, and resumed their seats for the return to Albany. It was an imposing spectacle. It was a practical illustration of the great preference of this mode of travel and conveyance. The American locomotive started with a train of five cars, containing nineteen or twenty persons each, besides the tender, and never did 'Brother Jonathan' as it was familiarly called, perform the trip in more beautiful style. It came down with its train in thirty-eight minutes, being at the rate of nineteen miles an hour, the last six miles were performed in fourteen minutes. The cavalcade with horses came down in sixty-eight minutes.

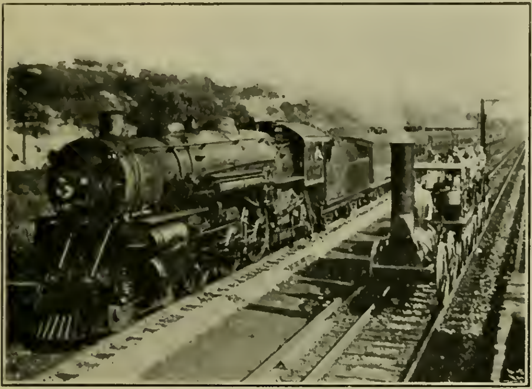
'Brother Jonathan' as it was familiarly called, is as yet decidedly in advance of 'John Bull'."



The "De Witt Clinton." Ready to Run Under Its Own Steam, July 17, 1921.
Photograph by Courtesy of N. Y. C. L. Magazine.

Other than the letter from Mr. David Matthew as given above we have no record of the early operations of the "De Witt Clinton" after December first, 1831. Interest in it, however, does not stop here, for on July 14th, 1921, almost ninety years from the day it made its initial run, it was taken out on the tracks of the New York Central Railroad and given an experimental run beside the Twentieth Century Limited at Harmon, about 32 miles from the Grand Central Station in New York City. A view of the two trains as they appeared running side by side is given below.

On July 17th the "De Witt Clinton" and cars made an official start under its own steam for the Pageant of Progress Exposition at Chicago, Ill. The pioneer locomotive did not, of course, make the entire trip under its own steam but was placed on flat cars and hauled to Chicago by Engine No. 999 of the New York Central. It was this latter locomotive that in 1893 attained a record of 112½ miles per hour. At Chicago the "De Witt Clinton" was again operated under its own steam and in a trip between Chicago and Englewood attained a speed of about fifteen miles per hour thereby proving that no rheumatism of age has crept into its joints.



THE "DE WITT CLINTON" AND "THE TWENTIETH CENTURY LIMITED," JULY 14, 1921.
Photograph by Courtesy of N. Y. C. L. Magazine.

A locomotive which shares much of the historical interest of the "De Witt Clinton" is the "John Bull" which now stands in The National Museum. On it is a placard which bears the following information: —

> "LOCOMOTIVE 'JOHN BULL' 1831
>
> "#1 Camden and Amboy R. R. Co.
>
> "The oldest complete Locomotive in America.
>
> "Built by George Stephenson & Son, Newcastle on Tyne, England, 1830-31. Shipped from Liverpool July 14, 1831, on the Ship Allegheny, bound for Philadelphia.
>
> "Gift of the Penna. R. R. Co. 1885.
>
> "On November 12, 1831, in the presence of members of the New Jersey Legislature, with Isaac Dripps acting as engineer, in a train with two cars, this locomotive made the first movement by steam in the state of New Jersey, at Bordentown where the railroad Monument now stands. The

(*Continued on Page* 23)

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, Editor.

HARTFORD, JANUARY, 1922.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

WHEN we consider what may happen to a water gauge on a boiler we may feel some surprise that there are not more accidents from low water for a water gauge is such a simple, harmless looking piece of apparatus that many are easily led to believe that it can never get out of order and that the utmost confidence can be placed in its indications. This is unfortunate, for the water gauge can become one of the most treacherous of indicators. The pressure gauge may be incorrect but in all ordinary cases the safety valve, if regularly tested and if not tampered with, will give a means of protection against over pressure. In the case of the water level in the boiler, try cocks are provided to check the reading of the gauge glass but usually these are not used as frequently as they might be. The fusible plug may act as a warning signal in the case of low water but this protective device is not as readily accessible as the safety valve and may become inoperative. The water gauge, therefore, should receive particular attention to see that it is always in first-class operating condition and in this regard we desire to point out to our readers the article on Page 3 of this issue of THE LOCOMOTIVE. In it, we believe, will be found a number of suggestions of value to the boiler room operator.

WM. R. C. CORSON.

Wm. R. C. Corson Elected Vice-President and Treasurer.

AT a special meeting of the Board of Directors of The Hartford Steam Boiler Inspection & Insurance Co., on October 25th, 1921, Mr. Wm. R. C. Corson was elected vice-president to fill the vacancy caused by the death of the late Francis B. Allen. The office of treasurer was re-established at the same time and Mr. Corson was selected to fill the position.

Mr. Corson entered the service of this Company in 1907 as assistant to Chief Inspector F. S. Allen in the mechanical engineering department. In February, 1909, he was elected assistant secretary and on November 20, 1916, he became secretary of the Company.

Mr. Corson is a member of the Board of Water Commissioners of the City of Hartford. He is a member of the Board of Directors of this company and is also identified as a director or trustee of many of Hartford's institutions, among them the Hartford-Ætna National Bank, the Wadsworth Atheneum, the Watkinson Library, the Retreat for the Insane and the American School for the Deaf.

Louis F. Middlebrook Elected Secretary.

THE many friends and associates of Mr. Louis F. Middlebrook, particularly those in insurance circles, will learn with pleasure of his election by the Board of Directors to the position of secretary of this company. The change became effective on October 25, 1921.

Mr. Middlebrook has practically grown up with this company since he entered its employ on March 1st, 1885, and has held the position of assistant secretary since July, 1897. His familiarity with the business, including his experience in agency work, accounting, underwriting and general correspondence make him specially fitted for the position to which he has been elected.

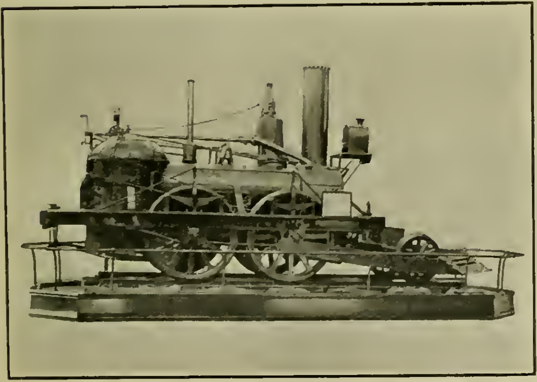
Mr. Middlebrook has been prominent in naval affairs and prior to the war with Spain took an active and important part in the establishment of the Naval Militia in Connecticut. He was commissioned an ensign in the United States Navy during that war and served until its close, when he returned to his duties with the company in the fall of 1898. He is a member of several naval and historical societies and of the Hartford Golf Club.

Some Historical Notes on the Early Locomotives in America.

(*Continued From Page* 19)

John Bull was in continuous service from 1831 to 1865, during which time it was altered and added to. It was exhibited at the Centennial Exposition, 1876, and at the Exposition of Railway Appliances, Chicago, 1883. It was placed in the United States National Museum in 1885, and remained there until 1893, when (April 17-22) it was run under steam from New York to the World's Columbian Exposition, where for a time it made daily trips upon the Exposition tracks. On December 13, 1893, it was returned to Washington, having made the last trip under steam on that date.

"Original Dimensions: Weight 10 tons (22,425 lbs.) — Boiler 13′ long x 3 ft-6 inches diameter: Cylinder 9 x 20 inches: Driving wheels 4 ft 6 inches diameter, cast iron hub, locust spokes, wrought iron tires shrunk on, flange 1½ inches deep: 62 flues, 7 ft-6 inches long by 2 inches diam.: Furnace 3 ft-7 in. by 3 ft-2 inches high: Steam ports 1⅛ by 6½ inches, Exhaust ports 1½ by 6½ inches: Throw of eccentric 3½″: Grate surface 10.08 sq. ft.: Fire box 36 sq. ft.: Flue surface 213 sq. ft."

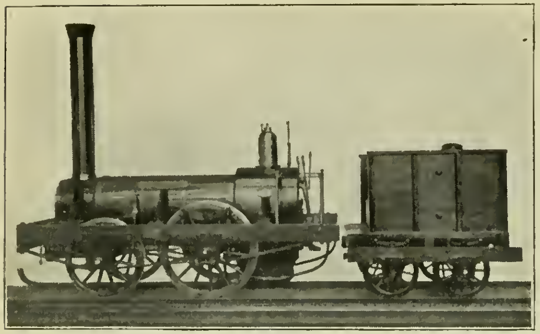


The "John Bull."

This information regarding the "John Bull" does not seem to agree altogether with the evidence relating to the "De Witt Clinton." It appears, from all the evidence that we can gather, that the "De Witt Clinton" made its first trial trip on July 5th, 1831, whereas the "John Bull" did not leave England until July 14th, 1831, and its first operation in America is recorded as taking place on November 12th, 1831. Controversy may be avoided, however, by saying that the "De Witt Clinton" is the oldest American built locomotive and the "John Bull" the oldest English built locomotive now in existence in the United States.

Among the models of the early locomotives at the National Museum is one of "Old Ironsides" which is illustrated on page 24 and which was built by Matthias Baldwin in Philadelphia, Pa., in 1832. It is said that this locomotive hauled the first passenger train in Pennsylvania.

There were, of course, many other locomotives of the early days about which many historical facts might be written but such de-



" OLD IRONSIDES."

scription is beyond the scope of this article. We cannot close, however, without a few remarks regarding the " Comet " of the Hartford and New Haven Railroad, a view of which appears on the front cover of this issue of THE LOCOMOTIVE. At the time of the incorporation of The Hartford Steam Boiler Inspection and Insurance Company in 1866 interest in steam locomotives was great and they were undoubtedly considered as one of the highest achievements of mechanical skill. The " Comet " was then a familiar sight in Hartford and, being representative of the spirit of progress, it is not difficult to understand why it was incorporated into the seal of this company and the name, " THE LOCOMOTIVE," given to this publication.

An Echo of The Park Central Hotel Explosion.

IN THE LOCOMOTIVE for March 1889 there appeared an account of a boiler explosion in The Park Central Hotel at Hartford, Conn. An echo of this accident is found in the following article which appeared in The New Haven Evening Register, New Haven, Conn., of November 14, 1921.

" Wellington Ketcham, an insurance agent, 83, of 85 Olive Street, dropped dead in the hallway yesterday as he was about to enter his room. Medical Examiner Scarbrough gave, as the cause of his death, heart disease. The relatives of Ketcham are unknown.

" Wellington Ketcham was formerly one of the best known hotel men in Connecticut having managed several popular resorts in different cities. In 1887 he was proprietor of the ill-fated Park Central hotel in Hartford at the corner of High and Allyn Streets.

" This hotel was almost completely demolished by an explosion of the boiler and a subsequent fire, 35 persons meeting their death. The catastrophe occurred in the night time and most of the victims were killed in their beds and their bodies recovered from underneath the ruins.

" Mr. Ketcham had one of the most remarkable escapes ever recorded in the annals of fires. He was placed on the missing list and search was being made for his body in the neighborhood of the office ruins. After hours of labor the firemen heard the faint barking of a dog. Renewing their efforts a great mass of debris was removed and underneath it was found Mr. Ketcham and the little dog whose barking had appraised the firemen of his presence. In the falling of the timbers, two heavy ones had arched over the body of Mr. Ketcham and protected him from serious injury. He was taken to the hospital and in a few days was able to be around as good as ever."

WRECK OF THE PARK CENTRAL HOTEL.

The explosion mentioned above, which was particularly violent, was evidently the result of over-pressure brought about by an inoperative safety valve. A reproduction of the sketch which accompanied the account in THE LOCOMOTIVE showing the wrecked building is given above.

The title page and index for Vol. XXXIII of The Locomotive, covering the years 1920 and 1921, is now available and may be obtained upon application to the Hartford Office of the Company.

One man was killed, two were injured and the ginning plant of Clark and McCowan, near Florence, S. C., was demolished by a boiler explosion on September 20, 1921. The boiler had been idle for six months and during this time had been repaired by welding on a patch about 14" x 24", the work being done by the oxy-acetylene process. When the boiler was put into service it exploded, the failure having its origin at the welded patch. The boiler was blown into the air and landed about 350 yards away.

BOILER EXPLOSIONS

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF MARCH, 1921 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
138	19	Section of heating boiler cracked			Vonhoff Hotel	Hotel	Mansfield, Ohio
139	19	Six headers fractured			Ford Motor Co.	Auto Mfg.	Springwells. Mich.
140	19	Section of heating boiler cracked			Atlantic Basin Iron Works	Garage	Brooklyn, N. Y.
141	19	Boiler exploded	1	3	Teis Zimmer	Wood Saw	Emden, Ill.
142	21	Section of heating boiler cracked			J. F. & P. Reagan	Hotel	Uniontown, Pa.
143	21	Manifold & two sections of heating boiler cracked			Brunswick Hotel	Hotel	Mansfield, Ohio.
144	21	Boiler exploded		1	Sterling Oil & Refining Co.	Drilling for Oil	Magna City, Kan.
145	22	Two tubes pulled out			L. Ferenbach Silk Co.	Silk Mill	Parsons, Pa.
146	23	Section of heating boiler cracked			J. R. Thompson	Restaurant	Chicago, Ill.
147	24	Steam pipe accident			The Wilkesbarre Co.	Power Station	Wilkesbarre, Pa.
148	25	Section of heating boiler cracked			Franklin County, Iowa	Court House	Hampton, Iowa
149	28	Cracked section			Cedar Rapids Cold Storage Co.	Cold Sorage	Des Moines, Iowa
150	29	Section of heating boiler cracked			Michael Golland	Mercantile Bldg.	St. Louis, Mo.
151	29	Section of heating boiler exploded			Charlesbank Homes	Apts.	Boston, Mass.
152	29	Two sections of heating boiler cracked			City of Cleveland	Police Station	Cleveland, Ohio
153	29	Heating boiler exploded			Rose Tree Hunt Club	Club	Media, Pa.
154	30	Ten sections of heating boiler cracked			Standard Plate Glass Co.	Plate Glass	Boston, Mass.
155	31	Three sections of heating boiler cracked			H. A. Metz & Co.	Laboratories	Brooklyn, N. Y.
156	31	Boiler exploded		12		Planing Mill	Monterey, Tenn.

MONTH OF APRIL, 1921.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
157	1	Boiler exploded	1	4	Cooper Saw Mill	Saw Mill	Mt. Olive, Ga.
158	1	Rendering tank exploded			Boise Butcher Co.	Slaughter House	Boise City, Idaho
159	2	Boiler exploded	2		Vermont Marble Co.	Marble Quarry	Stockbridge, Vt.

160	2	Boiler exploded	1		Love Brothers	Oil Drilling	El Dorado, Texas
161	2	Tire vulcanizer exploded			Advance Tire Co.	Tire Repairs	Little Rock, Ark.
162	4	Boiler bulged and ruptured			J. S. Bielfield Brewing Co.	Brewers	Thornton, Ill.
163	5	Accident to blow-off pipe		1	J. S. Martin Co.	Cheese Factory	Depauville, N. Y.
164	5	Boiler exploded	1	1	O. Born & A. Sanburn	Laundry	So. Bend, Ind.
165	6	Boiler exploded			Forter & Foster	Rice Field Drain.	Franklin, La.
166	7	Boiler exploded			State School	School	Delavan, Wis.
167	7	Two sections heating boiler cracked			Hotel Kingsport	Hotel	Kingsport, Tenn.
168	8	Tube ruptured and header cracked			Buffalo Cold Storage Co.	Cold Storage	Buffalo, N. Y.
169	10	Section of heating boiler cracked			Oliver Ames	Apt. House	Cambridge, Mass.
170	11	Failure of pipe fitting			Minnesota By-Product Coke Co.	Coke Co.	St. Paul, Minn.
171	11	Seven headers cracked			Ingersoll-Rand Co.	Air Compressors	Easton, Pa.
172	11	Mud drum pulled off nipples	3	3	Pacific Gas & Electric Co.	Power Station	San Francisco, Cal.
173	12	Non-return valve cracked			Central Products Co.	Auto Parts Mfgrs.	Detroit, Mich.
174	15	Two sections heating boiler cracked			Manchester School	School	Pittsburgh, Pa.
175	15	Two sections heating boiler cracked			Hancock School	School	Pittsburgh, Pa.
176	15	Section of heating boiler cracked			Penn School	School	Pittsburgh, Pa.
177	15	Section of heating boiler cracked			City of Rome	City Hall	Rome, Ga.
178	15	Section of heating boiler cracked			Borough of Wilkinsburg	School	Wilkinsburg, Pa.
179	16	Boiler exploded	2	3	Burt Ray	Saw Mill	Panther Creek, Ky.
180	16	Header cracked			Jacques Kahn Realty Co.	Mirror Mfgrs.	New York, N. Y.
181	18	Tube ruptured			Trinity-Portland Cement Co.	Cement	Dallas, Texas
182	18	Section of heating boiler cracked			Aaron Co.	Furniture Store	Connellsville, Pa.
183	19	Section of heating boiler cracked			Radcliffe College	College	Cambridge, Mass.
184	20	Section of heating boiler cracked			Sakura Silk Co.	Silk Mill	Kane, Pa.
185	21	Tube failure			Fordham University	College	Fordham, N. Y.
186	21	Boiler of locomotive exploded	3		Lehigh Valley Railroad	Railroad	Canandaigua, N. Y.
187	22	Tube ruptured			The Independent Breweries Co.	Ice Plant	St. Louis, Mo.
188	22	Boiler bulged and ruptured			Braude-Pierce Furniture Co.	Furniture	Warsaw, Ind.
189	22	Boiler exploded			T. A. Edmonds	Oil Refinery	Riverside, Texas
190	23	Boiler exploded		1	Ackerman Light Plant	Lighting Plant	Ackerman, Miss.
191	23	Boiler of locomotive exploded	2	1	Kansas City Southern Railroad	Railroad	Shreveport, Pa.
192	25	Header cracked			The Gutta Percha & Rubber Mfg.	Rubber Mfgrs.	Brooklyn, N. Y.
193	25	Stop valve ruptured			E. V. Connett Co.	Hat Mfgrs.	Newark, N. J.
194	26	Header cracked			Pittsburg Plate Glass Co.	Glass Mfgrs.	Charleroi, Pa.
195	26	Boiler exploded. See Locomotive, July 1921, page 194.	2		McKeithan Lumber Co.	Lumber	South Carolina
196	27	Two headers cracked			Glen Willow Ice Co.	Ice Plant	Glen Willow, Pa.
197	28	Two sections heating boiler cracked			Church of the Immaculate Heart	School	Chester, Pa.

MONTH OF APRIL, 1921 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
198	29	Tube ruptured			University of Missouri	University	Columbia, Mo.
199	30	Five sections heating boiler cracked			Hotel Belmore	Hotel	New York, N. Y.
200	30	Five headers cracked			Agasote Millboard Co.	Millboard	Fernwood, N. J.
201	30	Section of heating boiler cracked			Children's Aid Society	School	New York, N. Y.

MONTH OF MAY, 1921.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
202	2	Tube ruptured in economizer			Hammermill Paper Co.	Paper Mill	Erie, Pa.
203	2	Section of heating boiler cracked			Town of Broken Bow	School	Broken Bow, Neb.
204	3	Three sections heating boiler cracked			Forward Ave. School	School	Pittsburgh, Pa.
205	4	Nipple in heating boiler cracked			B. T. Van Nostrand	Loft Bldg.	Brooklyn, N. Y.
206	4	Section of heating boiler cracked			N. & P. Kiamie	Silk Importers	Brooklyn, N. Y.
207	5	Five sections heating boiler cracked			Charles Bernstein	Loft Bldg.	New York, N. Y.
208	5	Three superheater tubes ruptured			Galveston Ice & Cold Storage Co.	Cold Storage	Galveston, Tex.
209	6	Section of heating boiler cracked			City of Niagara Falls	School	Niagara Falls, N.Y.
210	6	Boiler exploded (1 HP)	1		Scott Williams Electric Shop	Repair Shop	El Dorado, Kan.
211	8	Boiler exploded			Schwager & Nettleton	Lumber Mill	Seattle, Wash.
212	9	Section heating boiler cracked			City of Taunton	School	Taunton, Mass.
213	10	16" Steam pipe burst	3	3	West Penn Power Co.	Power Plant	Fayette, Pa.
214	11	Boiler exploded		4	Cody Lumber Co.	Lumber Mill	Cody, Texas
215	11	Tube ruptured			Williamston Mill	Cotton Mill	Williamston, S. C.
216	12	Section heating boiler cracked and several Bundy tubes cracked			Boston Real Estate Trust	Stores & Offices	Boston, Mass.
217	17	Boiler ruptured			Clendenin & Co.	Tannery	Richmond, Ind.
218	19	Boiler exploded			Usher Brothers	Saw Mill	Shuqualak, Miss.
219	19	Header cracked			Eastman Kodak Co.	Camera Mfgrs.	Rochester, N. Y.
220	20	Tube ruptured			Kellogg Toasted Corn Flake Co.	Cereals	Battle Creek, Mich.
221	20	Boiler exploded		3	Arnold & Naudain	Saw Mill	Hockessin, Del.
222	21	Rendering tank exploded			Michigan Beef Co.	Slaughter House	Detroit, Mich.
223	23	Tube ruptured			H. A. McPherson	Laundry	Utica, N. Y.
224	26	Boiler exploded		4	W. A. Warden	Saw Mill	Stonewall, W. Va.
225	26	Section of heating boiler cracked			Fink Investment Co.	Apt. House	S. Francisco, Cal.

226	27	4" valve ruptured			West Penn Power Co.	Power Plant	Connellsville, Pa.
227	27	Failure of blow-off pipe			Nestle's Food Co.	Milk Products	Oneonta, N. Y.
228	28	Accident to rendering tank	1		Armour & Co.	Meat Packers	Jersey City, N. J.
229	28	Section of heating boiler cracked			Polish R. C. Church	Church	Pittsfield, Mass.
230	28	Boiler shell bagged and ruptured			Hocking Valley Fire Clay Co.	Firebrick	Nelsonville, O.
231	29	Eight headers cracked			Susquehanna Collieries Co.	Coal Mining	Minersville, Pa.
232	29	Superheater tube pulled out			American Gas & Electric Co.	Power Station	Atlantic City, N. J.
233	30	Section of heating boiler cracked			John R. Thompson Co.	Restaurant	Philadelphia, Pa.

MONTH OF JUNE, 1921.

234	3	Fire tube ruptured			Dexter Ice, Fuel & Power Co.	Ice & Power	Dexter, Mo.
235	4	Steam pipe burst	1		Pittsburg Municipal Hospital	Hospital	Pittsburgh, Pa.
236	5	Boiler bagged and ruptured			London Ice Co.	Ice Plant	London, Ohio
237	7	Failure of crown sheet			Crossett Lumber Co.	Lumber Mill	Crossett, Ark.
238	7	Header pulled off tubes	1		Alpha-Portland Cement Co.	Cement Factory	Bellevue, Mich.
239	9	Draw-off cock on rendering tank failed			City of Beaumont	Abattoir	Beaumont, Texas
240	10	Tube ruptured			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
241	12	Stop valve burst			Adirondack Electric Power Corp.	Power Station	Utica, N. Y.
242	13	Boiler injured from low water			Chevrolet Motor Co.	Automobiles	St. Louis, Mo.
243	13	Tube ruptured			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
244	13	Tube ruptured			Lehigh Portland Cement Co.	Cement	Allentown, Pa.
245	14	Failure of crown sheet			Susquehanna Collieries Co.	Coal Mining	Minersville, Pa.
246	14	Header cracked			Pittsburgh Plate Glass Co.	Glass Mfgrs.	Ford City, Pa.
247	15	Eight headers cracked			American Steel & Wire Co.	Steel Mill	Waukegan, Ill.
248	15	Boiler exploded, damage amounted to $8000			Elizabethtown Smelting Co.	Smelting	Newark, N. J.
249	15	Accident to boiler		1	Hannibal Light Plant	Lighting Plant	Hannibal, Mo.
250	15	Tube ruptured	1	3	Richmond Light & Railroad Co.	Power Station	Staten Island, N.Y.
251	16	Boiler bagged and ruptured			Peoples Ice & Cold Storage Co.	Ice Plant	Claremore, Okla.
252	16	Furnace sheet of boiler collapsed			Keystone Sand & Supply Co.	Stand & Stone	Neville Island, Pa.
253	16	Blow off tank exploded	1		Polk Sanitary Mills Co.		Indianapolis, Ind.
254	17	Boiler exploded		2	Tug "Goldie W"	Tug	Sheboygan, Wis.
255	17	Two fittings in steam line ruptured from water hammer			Johns-Manville, Inc.	Fiber Products	Lockport, N. Y.
256	17	Heating boiler exploded		2	Swedish Baptist Church	Church	Moline, Ill.
257	18	Boiler bagged and ruptured			Texas Gas & Electric Co.	Power Plant	Beeville, Texas
258	18	Section heating boiler cracked			Commissioners of Union County	Court House	Liberty, Ind.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1921

Capital Stock, . . $2,000,000.00

ASSETS

Cash in offices and banks		$366,891.88
Real Estate		90,000.00
Mortgage and collateral loans		1,543,250.00
Bonds and stocks		6,188,435.00
Premiums in course of collection		728,199.44
Interest Accrued		116,654.78
Total assets		9,033,431.10

LIABILITIES

Reserve for unearned premiums		$4,512,194.11
Reserve for losses		205,160.80
Reserve for taxes and other contingencies		388,958.85
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,927,117.34	
Surplus to Policy-holders		**$3,927,117.34**
Total liabilities		$9,033,431.10

CHARLES S. BLAKE, President.
W. R. C. CORSON, Vice-President and Treasurer,
L. F. MIDDLEBROOK, Secretary.
E. SIDNEY BERRY, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.
J. J. GRAHAM, Supt. of Agencies.

BOARD OF DIRECTORS

ATWOOD COLLINS, President, Security Trust Co., Hartford, Conn.

LUCIUS F. ROBINSON, Attorney, Hartford, Conn.

JOHN O. ENDERS, President, United States Bank, Hartford, Conn.

MORGAN B. BRAINARD, Vice-Pres. and Treasurer, Ætna Life Insurance Co., Hartford, Conn.

CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.

FRANCIS T. MAXWELL, President, The Hockanum Mills Company, Rockville, Conn.

HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.

D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.

DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.

JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.

EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.

MORGAN G. BULKELEY, JR., Ass't Treas., Ætna Life Ins. Co., Hartford, Conn.

CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.

WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Company.

SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.

Incorporated 1866. THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLYWHEEL EXPLOSIONS AND ENGINE BREAKAGE

Department.	Representatives.
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, CT., 404-405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. E. Mason Parry, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'l'v'd	J. F. Criswell, Manager. P. M. Murray, Ass't Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	H. A. Baumhart, Manager. L. T. Gregg, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J. H. Chestnutt, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, General Agent. E. Mason Parry, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnett, Ass't Chief Inspector.
PHILADELPHIA, Pa., 142 South Fourth St.	A. S. Wickham, Manager. Wm. J Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrott Bldg.	Geo. S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	McCargar, Bates & Lively, General Agents. C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.

CARNEGIE LIBRARY,
PITTSBURGH, PA.

A CONSTRUCTIVE SERVICE

extended to anyone interested

in *BOILER ECONOMY and SAFETY*

Write to-day for details to the HOME OFFICE of

THE HARTFORD STEAM BOILER
INSPECTION and INSURANCE CO.

HARTFORD CONNECTICUT

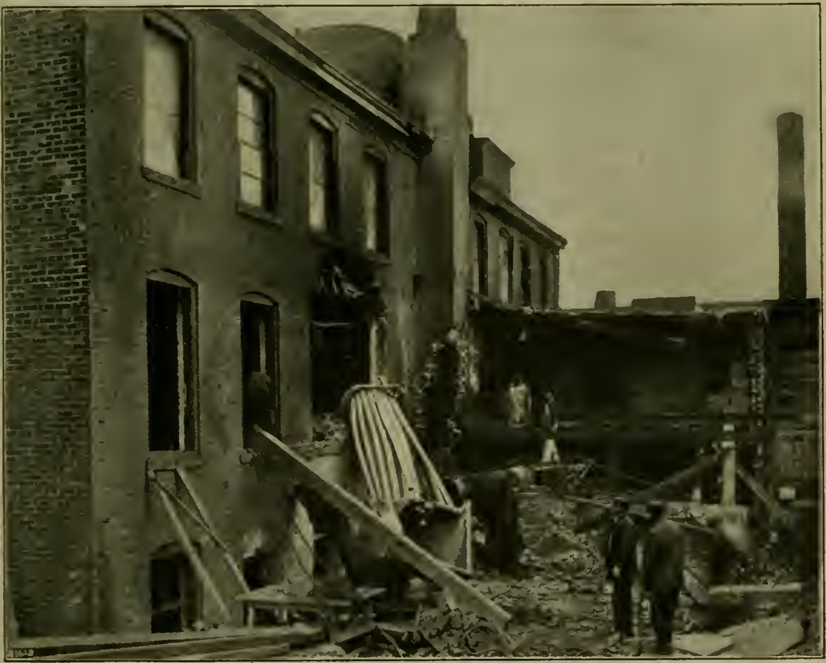
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIV. HARTFORD, CONN., APRIL, 1922. No. 2.

COPYRIGHT, 1922, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



BOILER EXPLOSION AT BRIDGEPORT, CONN.

Boiler Explosion at Bridgeport, Conn.

MONDAY, the second of January, 1922, was a legal holiday in many parts of the country and a large number of manufacturing plants and business houses closed for the day. Celebrations to welcome the New Year were numerous but the forces of nature stole a march on everyone and staged, in a boiler explosion at Bridgeport, Conn., a demonstration that outdid them all. Whether or no there was much temptation placed in the way of those who celebrated the season, certainly much encouragement was given the forces that can be stored in a boiler to show what they could do.

The boiler was an old one — we do not know just how old, but we believe that the age was at least twenty years — of the locomotive type and of lap seam construction. The metal was severely corroded and, worst of all, repairs had been made by autogenous welding. The owners had bought the boiler, apparently with the best of intentions, from a second hand dealer and probably this dealer sold the boiler with the belief that it was in reasonably good condition. It was said also that an inspector had passed the vessel as being acceptable for a pressure of 100 lbs. and with this belief the owners thought they had secured a bargain. Two months after the boiler was installed, however, the explosion occurred and property damage to the extent of about $8,000. was done.

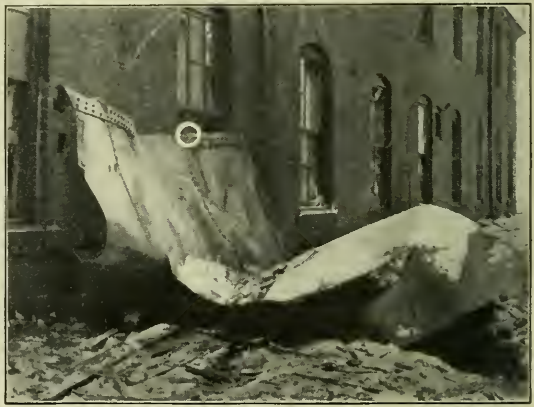


Fig. 1.

Newspaper reports stated that the man in charge of the plant at the time had just stoked the furnace of the boiler and had walked a short distance away to turn on an electric light, when the accident occurred. It was said that this man was hurled out of the boiler room by the force of the explosion, but miraculously escaped injury.

There were two boilers at the plant and these were placed side by side in a basement over which there was a one story shed. When the explosion occurred, the barrel-sheet of the boiler was torn off and the remainder — by far the larger part — was hurled up and against the brick wall of an adjoining building, tearing a hole in it and coming to rest in the position shown in the picture above. The barrel-sheet itself was blown up and over the remaining part of the shed and landed in an alley-way between the shed and the next building, as shown in the picture on the opposite page. Just above the third window from the left of the picture the scar may be seen where the plate first struck the brick wall.

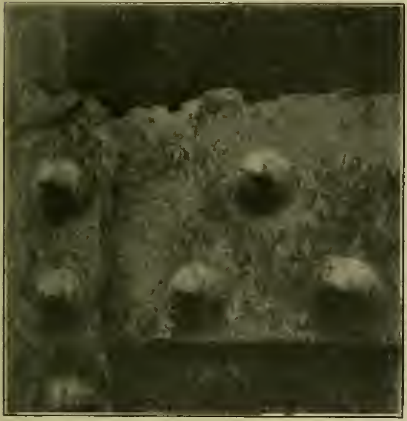


Fig. 2.

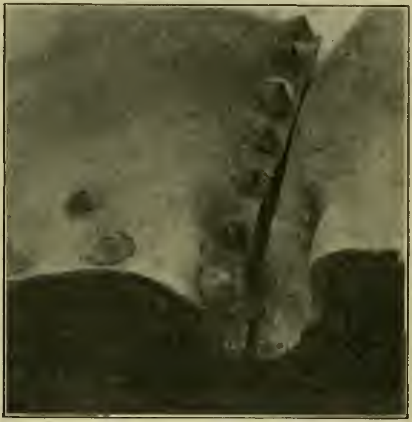


Fig. 3.

A close-up view of the part enclosed by a white circle in Fig. 1 is given in Fig. 2 above and in it may be seen the welding that was done at the junction of the longitudinal and girth seams. The other end of the joint is illustrated in Fig. 3 in which the corroded condition of the plate can be fairly well distinguished.

Competent inspection would have shown the danger of using this boiler and the loss in time and money which the owners had to suffer would thereby have been avoided.

The Fitting of Keys in Crossheads and Flywheels.

A CHAIN is no stronger than its weakest link and in an engine there are so many "links" upon which the safety of the whole structure depends that considerable care must be exercised to see that all parts are in as good condition as circumstances will permit. Engines should be overhauled from time to time and this, very often, calls for a disconnecting of several parts. At times it may be necessary to replace old and worn parts with new. In such replacement a great deal of attention must be paid to securing correct fits or mating of the new parts with the old. In particular, we have in mind the fitting of the piston rod into the crosshead which, when these two are keyed or gibbed together, is a job calling for no small degree of skill.

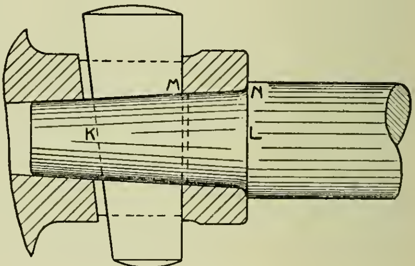


Fig. 1.

Attention need hardly be called to the desirability of obtaining the services of a first-class mechanic skilled in the fitting up of engines to do such work. Such men are not always available however, and the owner may have to be contented with a less skilled workman. In such cases the owner will naturally be interested in knowing how the work should be done so that he may give instructions to the mechanic he employs. Even with skilled hands to do the work the owner will naturally have some interest in the reasons for the steps that are taken.

The more usual construction that is found in this type of crosshead and piston rod joint is the one in which the end of the rod is tapered, although the straight cylindrical end is sometimes used. These two variations in the general construction are illustrated in Figs. 1 and 2. The end of the rod, where it fits into the crosshead, is sometimes relieved or undercut over a length slightly greater than that taken up by the keyway. This is illustrated in Fig. 3. The cylindrical end is also made with the outer or tip section of a slightly smaller diameter than the inner section, the part between the two being undercut. It should be borne in mind, however, that any reduction in the diameter of the rod will naturally weaken it and undercutting should not be done without due consideration of this effect. Furthermore, sudden changes in diameter with sharp corners should always be avoided because very severe local stresses may be produced thereby. The end of the rod should also be rounded off as shown to avoid possible cutting when it is pulled into the crosshead.

A description will be given of the method of fitting the tapered end and from this it will not be difficult to see what treatment should be given the cylindrical end.

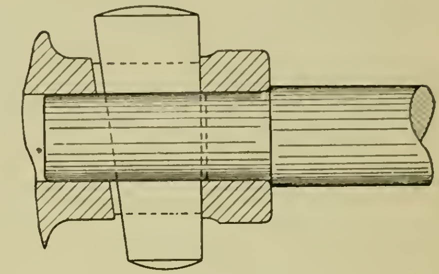


Fig. 2.

The first step is to fit the tapered end of the rod into the hole in the crosshead so that the two parts will bear evenly and fully on the surfaces which touch each other and so that, when pushed together by hand, there will be a slight space between the end of the crosshead boss and the shoulder on the rod. This space is for the "draw" and will be taken up when the key is driven in thereby providing a snug, tightly fitting joint. The amount allowed for this "draw" will vary with the size of the rod and the degree of taper. On large diameter rods not so much would be allowed as on small rods. With a rod diameter of 2½″ about 1/16″ would be correct. If the rod has a cylindrical end, the two parts should go together with what a machinist terms a "push fit."

The tapered end of the rod should be lightly smeared with Prussian blue and the two parts pushed together by hand and then given a slight turning or twisting motion. When the parts are separated, those surfaces which had the closest fit will have the blue fairly well rubbed off and should be carefully filed down with a fine cut file until a neat fit is obtained over the entire length of the taper. It will be noted that no small degree of skill is called for in this fitting as a full bearing must be secured while keeping the diameters such that the proper "draw" is provided.

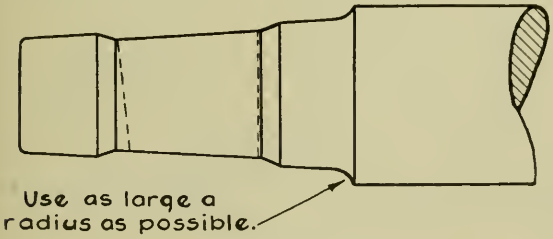


Fig. 3.

After this fit is secured, the next step is to obtain the proper relation between the key and the keyway or slot in the crosshead. This is shown in Fig. 4 on p. 28. The key, in this instance, has been shown with the tapered edge facing inward. The arrangement may be the reverse from this but, whichever it may be, it is desirable that the straight edge A-A be at right angles to the axis C-C. If the face B-B of the crosshead has been turned square with the bore this condition of the key may be insured by making the edges A-A and B-B parallel. Sometimes the key is tapered on both edges. In such a case a vertical dividing line or axis may be scribed on it and this line may then be used as a reference to obtain the right angle condition. We might add that it is not absolutely essential that the key and the axis of the bore be at an exact right angle. There may be some deviation from this but whatever it is should be carefully noted.

The position of the keyway in the rod should be such that the relation shown in Fig. 1 will be obtained when the shoulder on the rod is brought up firmly against the crosshead. Note that it is well to provide some clearance at the front end of the keyway in the rod. It will be sufficient to make this 1/32″.

While the position of the keyway in the rod may be obtained with comparative ease it must also be borne in mind that the tapered side of this keyway must make the proper angle with the axis of the rod. The key should be placed in the slot and, while it is bearing against the tapered side, its angularity with the axis of the rod should be measured. This angularity should be the same as that given the key when placed in the crosshead and brought to bear against the straight, non-tapered side. If this is not done, the key, when the parts are

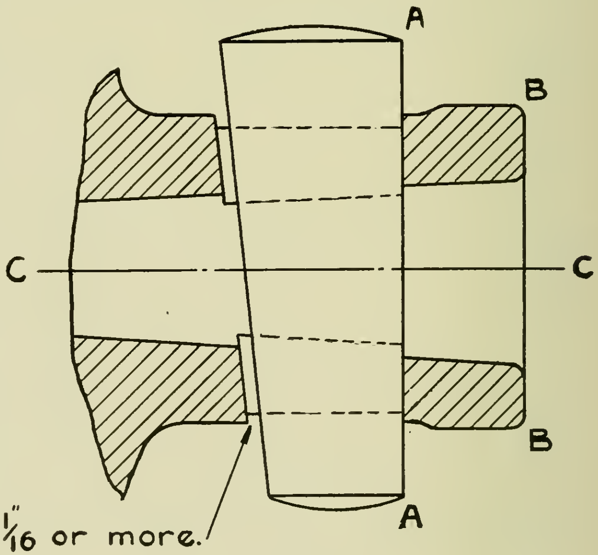


Fig. 4.

assembled, will not have a full bearing over its entire length and severe local stresses may be set up.

The joint may now be assembled, the key placed in position and then driven in until the shoulder on the rod is brought up firmly against the end of the crosshead. By this method of fitting, a tight joint is made by pulling the tapered rod rigidly into the crosshead. The holding stresses will be a hoop tension or tensile stress in the metal surrounding the rod with a corresponding compression in the rod itself. These two stresses produce a pressure on the bearing surfaces which thereby set up a large frictional force to hold the joint together. In addition there is a tensile strength lengthwise in the rod between points K and L and compression in the crosshead between points M and N. See Fig. 1. Of course when the engine is operating there will be alternate compressing and pulling of the cast metal beyond the point M, but the crosshead has been designed by the maker to carry this stress, provided, of course that no accident occurs. This is a tensile stress that can be predetermined, whereas the tensile stress that can be set up by an improperly fitted key can very readily become severe enough to wreck the best of designs. The illustration shows a crosshead that was broken by an improperly fitted key.

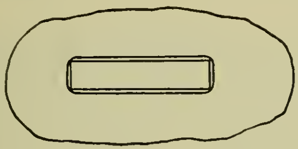


FIG. 5.

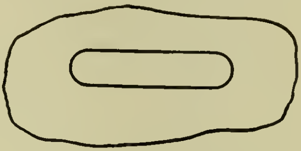


FIG. 6.

There are a few points regarding this fitting of the key in the crosshead that require particular care. If a rectangular key is used the corners should be relieved because it is difficult to obtain a perfectly square cornered hole in the crosshead. A key with square corners will almost certainly produce the effect shown in Fig. 5, which condition cannot help but set up stresses tending to shorten the life of the crosshead. An excellent way to avoid any such trouble is to make the key with full rounded edges as shown in Fig. 6. Of course this requires possibly more time to fit than a rectangular key but the stresses are more equally distributed. If a rectangular key cannot be avoided it should have the corners relieved.

It is not always easy to separate a rod and crosshead when they have been drawn firmly together on a taper joint. For such work a

" driving out " set of keys is very helpful. This set is composed of three specially formed pieces which are shown in Fig. 7 on Page 40 assembled in place and ready for use. By striking on the center wedge, B, the joint may very readily be eased up.

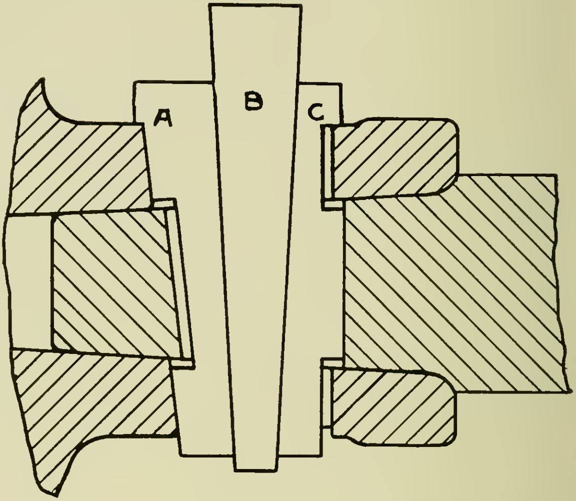
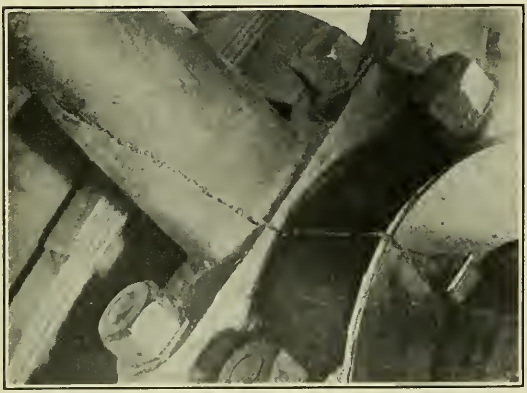


Fig. 7.

Some mention might also be made of the keying of wheels and pulleys to shafts. The function of a key used for this purpose is to prevent turning between the wheel and the shaft, endwise motion or sliding usually being prevented by set screws or by the compressing of a split hub on the shaft. For this reason the key should be a close fit on the sides but should have a clearance at the top. If this clearance is not provided, the load, when the hub bolts are tightened up, will be concentrated over the key, and the stresses tending to break the hub will be very much greater than if the load were equally distributed over the shaft. The illustration herewith shows a flywheel hub that was broken in this manner. The key had first been driven into place without allowing for the proper clearance and the hub bolts were then heated, put into place and pulled up tight. When the bolts cooled they of course exerted an intense clamping effect on the hub. The load was localized, however, over the key and, although failure did not take place immediately, the hub, no longer able to withstand the severe stress, broke, as shown, about a month later.



Flywheel Broken by Key.

The Significance of Draft with Some Notes on the Construction of Steel Smokestacks.

CHIMNEYS or smokestacks are built to serve two purposes. Usually the first consideration is the draft required, but some thought must almost always be given the question of delivering the products of combustion at a sufficiently high point so that they will not be obnoxious to the community. This latter consideration is often governed by local ordinances.

Stack Blown Down and Roof Wrecked by High Winds.

Draft, or the ability of a chimney to draw air through the fuel bed, depends upon the fact that the weight of a given volume of air or gas decreases when it is heated. To fully explain the principle of chimney draft, resource must be had to the atmospheric pressure. The air or atmosphere in which we live envelops the earth like a great hollow sphere or shell which physicists have estimated is about sixty miles in thickness. Because of the pull of gravity on this envelope of air a pressure is exerted upon the surface of the earth which amounts to 14.7 pounds per square inch of area at sea level. The further we go from the surface the less the pressure becomes. For instance, suppose we have a boiler room at the sea level with a chimney 100 feet high. The pressure in the boiler room would be 14.70 lbs. and the pressure at the top of the stack would be about 14.65 lbs. The difference of .05 lbs. would be caused by the 100 ft. of air between the two levels. If we consider the furnace of the boiler when there is no fire in it, the pressure on the under side of the grates would be 14.70 lbs. and on the upper side of the grates it would also be 14.70 lbs. Of this 14.70 lbs. pressure, .05 lbs. is caused, both on the upper and lower side, by the 100 ft. of air that we have under consideration. Suppose, however, that we put a fire under the boiler and that the gas in the chimney becomes so heated and expanded that the weight of one cubic foot is but one-half that when cold. The pressure exerted by 100 ft. of this gas in the chimney would only be one-half its former value or it would be

.025 lbs. To this we would have to add the weight of the cold air above the top of the chimney (14.65 lbs.) so that the total pressure in the furnace *above* the grates would be 14.675. But we have not heated the outside air so that the pressure *under* the grates would remain at 14.70 lbs. There would then be a difference in pressure on the two sides of the grates of .025 lbs. which would cause air to flow through them. As fast as this occurred, however, combustion would take place thereby maintaining the temperature in the stack and the difference in pressure above and below the grates.

TABLE I
Size of Chimneys for Steam Boilers.

Diam. Inches	Height of Chimney in feet								
	50	60	70	80	90	100	110	125	150
	Commercial Horse Power of Boiler								
18	23	25	27	29					
21	35	38	41	44					
24	49	54	58	62	66				
27	65	72	78	83	88				
30	84	92	100	107	113	119			
33		115	125	133	141	149	156		
36		141	152	163	173	182	191	204	
39			183	196	208	219	229	245	268
42			216	231	245	258	271	289	316
48				311	330	348	365	389	426
54					427	449	472	503	551
60					536	565	593	632	662

Thus we see that there are two fundamental methods of increasing the draft. The one is to increase the difference in temperature between the inside and the outside of the stack. The other is to increase the height of the stack while holding the temperature difference the same. In the interest of economy, however, as much heat as possible must be taken from the hot gases which in turn decreases their temperature and requires a greater height of stack.

The cross sectional area of a chimney depends upon the kind of coal, the amount to be burned in a given time and the velocity of the gases in the stack. The height depends upon the draft pressure required to burn the coal at the desired rate and also upon the temperature of the gases in the stack. The large number of unknown variables make the field of chimney design a difficult one and proportions that have been found, in years of practical experiment, to give good results are relied upon rather than theoretical formulae. The proportions as given by Kent's Handbook for Mechanical Engineers have been used for many years and are as given in Table I on page 42.

Chimneys are built of brick, concrete or steel. The first two materials named are only used for self-supported stacks or those whose weight and design of base are such that no guy wires are necessary. Steel chimneys are also built to be self-supporting but the smaller size steel chimneys are usually braced against the wind pressure by the use of guy wires.

The wind pressure varies greatly with the wind velocity. With a round stack the relation between the two is expressed by the formula $P = .0029 V^2$ in which P is the pressure in pounds per square foot of projected area of the stack and V is the velocity of the wind in miles per hour. This relation has been plotted as a curve in Fig. 1. From this curve we see that low wind velocities produce but little pressure

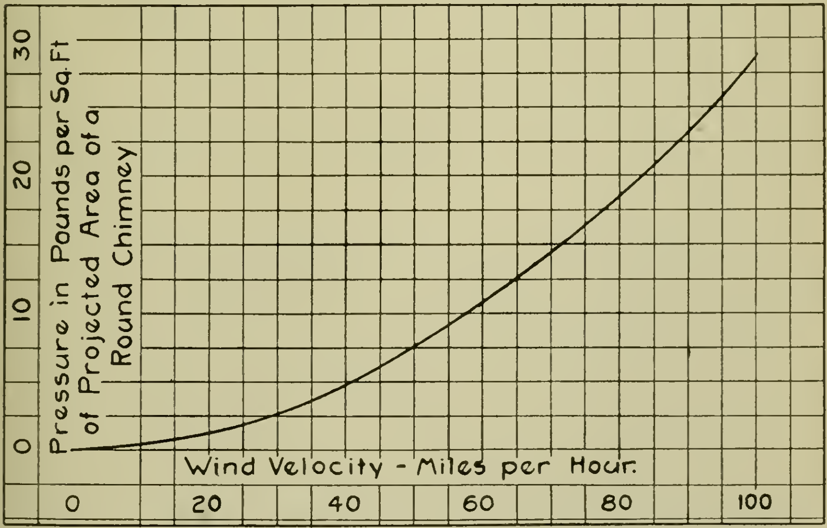


Fig. 1.

but that with the higher velocities the pressure increases very rapidly. A wind velocity approximately 100 miles per hour is classed as "an immense hurricane" and while such a wind storm is unheard of in many sections of the country, nevertheless, engineers base their designs of guy wires on this velocity. It will be noted that a wind velocity of 100 miles per hour corresponds to a pressure of 30 lbs. per square foot of projected area. We might add that by "projected area" is meant the diameter of the stack multiplied by the height. Thus the total pressure on a 100 ft. stack 24″ in diameter, would be 2 ft. x 100 ft. x 30 lbs. or 6,000 lbs. total.

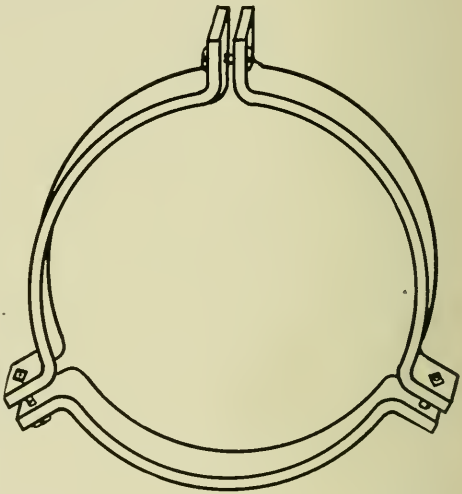


Fig. 2.

Guyed stacks are not commonly built in sizes greater than 6 ft. in diameter or 100 ft. in height. They are guyed with one, two or three sets of guys having three or four strands in each set. The greater the number of sets of guys the greater, of course, will be the stability of the stack. For general practice it might be well to use one set for stacks 50 feet or less in height, two sets for stacks between 50 and 100 ft. and three sets for stacks above 100 ft. The guys are attached to the stack by means of an iron ring made as shown in Fig. 2 and at the lower end are secured to a building or to an anchor, such as a heavy block of concrete, buried in the ground. If but one set of guys is used, the ring in the stack is usually placed at about two-thirds of the height above the base. If two sets are used it is common practice to place one at 2/5 and one at 4/5 of the height.

In determining the size of the guy wires it is assumed first of all that the wind is blowing directly in line with one of the guys. If one guy is used it is assumed to carry the load caused by the wind pressure on all the stack above the guy ring and that on two-thirds of the distance between the ring and the foundation. If two guys are used the upper one is figured for all the stack above its ring plus two-thirds of the space between the upper and lower ring; the lower one is figured for two-thirds of the sections both above and below it.

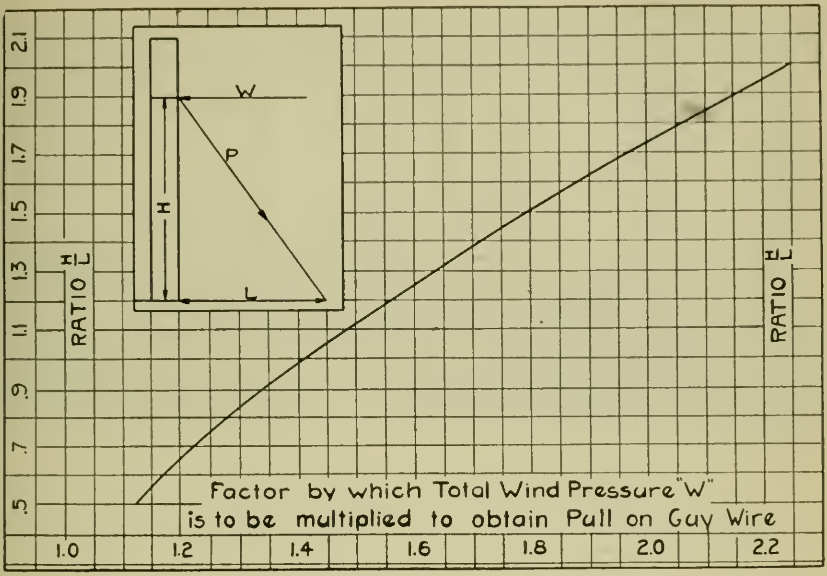


FIG. 3.

The guy wires must, of course, make an angle with the stack and the pull on them will be more than the total horizontal force of the wind. The curve in Fig. 3 has been worked out to show the relation between the two. For ready reference the ratio of height to horizontal distance has been plotted instead of the value of the upper or lower angle of the guy wire (See the sketch in Fig. 3). Thus for a ratio of $\underline{H}$ of 1.4, which represents average practice, the total wind pressure W that any one guy is to carry should be multiplied by 1.5 to obtain the actual pull on that guy. To allow for the initial tension, that must exist even when there is no wind, this assumed load should be increased 50%.

As an example, suppose that we have an 80 ft. stack, 4 ft. in diameter, to be supported by two sets of guys. The upper set would be placed at 4/5 x 80 or 64 feet from the base and the lower set at 2/5 x 80 or 32 feet from the base. The wind pressure carried by a guy in the upper set would be:—

(16 ft. + (2/3 x 32 ft.)) x 4 ft. x 30 lbs. = 3199 lbs.

Assuming a ratio of $\frac{H}{L}$ of 1.4 we must increase this by 50%

3199 lbs. x 1.5 = 4798 lbs.

This must be increased again by 50% to allow for initial tension.

a. Stacks Wrecked by Wind.
b. Gin Pole Being Erected.
c. Gin Pole in Place.
d. New Stack Going up.

$$4798 \text{ lbs.} \times 1.5 = 7197 \text{ lbs.}$$

which is the assumed maximum pull that the guy will ever be called upon to withstand. From Table II we find that a 9/16″ galvanized iron wire rope would carry the load.

The lower guy would figure as follows: —

$$\left((2/3 \times 32) + (2/3 \times 32) \right) \times 4 \times 30 = 2558 \text{ lbs. wind pressure}$$

$$2558 \times 1.5 \times 1.5 = 5775 \text{ lbs. total.}$$

which would call for a ½″ galvanized iron wire rope. Note that in

TABLE II

Ultimate Strength of Galvanized Iron Wire Rope Composed of 6 Strands and a Hemp Center, 7 or 12 Wires to the Strand.

Approximate diam., inches	Circumference inches	Approximate Breaking Strain in Pounds
5/16	1	2800
3/8	1 1/8	3600
7/16	1 1/4	4600
1/2	1 1/2	6400
9/16	1 3/4	8800
5/8	2	11600
3/4	2 1/4	14600
13/16	2 1/2	18000
7/8	2 3/4	22000

the selection of a guy rope practically no factor of safety is assumed other than the remote possibility of the wind pressure reaching a high value and the allowance that is made for initial tension. However, if the wind velocity is 50 miles per hour, which is classed as a " very high storm," the wind pressure is but 7½ lbs. per square foot instead of 30, so that ordinarily, the guy is not heavily stressed. Of course in localities where extreme high wind velocities are common, a larger strand should be used.

The sections of the stack should " shingle " on the inside. This is to avoid, as far as possible, the entrance of water into the joint which might occur when the stack is not in use. To protect the joint on the outside it may be caulked tight. The rivets, for a stack made of 1/4″ plate, would ordinarily be 1/2″ in diameter and spaced 2″ on centers.

Little can be done to prevent corrosion on the inside of a stack but the outside should be protected by a good stack paint and a new coat should be applied from time to time.

The Story of Two Staybolts.

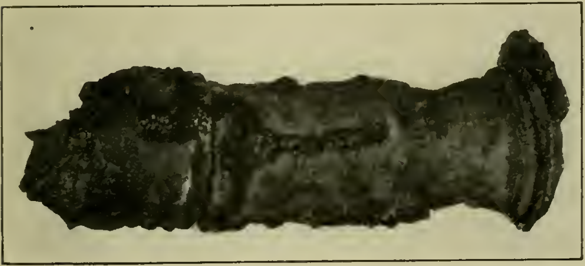
CHARACTERS: *Olde Staybolt* — Much wasted and thinned from age, hard service and bad contact; *Newe Staybolt* — Full size and almost perfect in shape, but split in two parts lengthwise.

TIME, Recently (1921).

Olde Staybolt: Look out, Longfellow, and watch who you are rubbing against!

Newe Staybolt: Beg pardon, sir; I did not mean to rub you so hard; but who are you anyway? You certainly look pretty much used up.

Olde: Oh, I don't know! You look like a split in the Democratic party yourself, but I see that you are but one staybolt when you are pulled together.



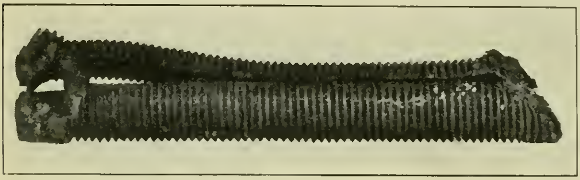
Olde Staybolt.

Newe: Now don't get rusty. Even if you did nearly lose your head while on the job. Let's be friends, since we have both reached the end of our usefulness in our present state. Let's have your history. How old are you, and where have you put in your time?

Olde: Perhaps my story won't be so interesting when you hear it, because I was on the job when three men were killed, due to a weakness of myself and seven companions.

Newe: You don't mean that, do you? Surely, you were not guilty of killing three men?

Olde: Yes, but I couldn't prevent the loss of the innocent lives. I offered resistance to it to the last ounce of strength in my body, but finally had to give way.



Newe Staybolt.

Newe: Well, I'm interested. Tell me the history of your life experience. We both have plenty of time now; we may be here in the scrap pile for several months.

Olde: Well, I was put in a horizontal firebox boiler, commonly called the oil-well type, nearly twenty years ago.

Newe: Pardon me, but what do you mean when you say, oil-well type? Why do you use that term?

Olde: Oil-well, or oil-field, boilers, are boilers designed light in weight and cheap in price and usually built without any special supervision. They are made light in weight because they are often taken to hilltops and mountainsides that are sometimes almost inaccessible places. I have also heard old-time oil and gas men say that boilers built of thin plate were quick steamers, especially when made with thin crown sheets. Owing to the difficulties of moving them these boilers are often left standing idle where used, as the cost of taking them to another location would about equal the cost of a new boiler.

Newe: You say that the boiler was built without any special supervision. Do you mean that there was no shop inspector on the job when it was built?

Olde: Inspector! No! not on oil-well boilers. They are built and used without inspection.

Newe: I'm surprised! Who, for the love of Pete, determined the pitch of the staybolts and the joint efficiency, and so on?

Olde: Oh, the boilermaker, or sometimes a shop draftsman did that. In what they miscalled the good old days, the old-time boilermaker was guided by the Government marine rules. Of course these rules are ancient, but you know some folks don't believe in newfangled rules and butt straps for steam boilers. You see, they could make oil-well boilers fast. They punched the rivet and staybolt holes full size or very nearly so, and if the plates at the joints did not fit snugly, a 200 lb. boilermaker would put them together by the judicious use of a 16 lb. sledge.

Newe: Gee! But wouldn't the plates be flat along the longitudinal seams?

Olde: Sure thing, for a short space, but no one objected. There was no inspector on the job, and the purchaser knew next to nothing about boilers. The rivet holes would be brought in line by the use of a drift pin. Of course the metal was abused and fatigued some, but after the riveting was done, no one could see that.

Newe: Well, go on with your story.

Olde: That is easy enough to tell, but how to get the proper parties to profit by the experience is what bothers me. You see, I was 7/8″ diameter over the threads when put in the side sheet of the boiler nearly twenty years ago. Now a 9/32″ sheet does not have many threads, but I managed to keep a pretty good hold in the plate all these years. The metal around the hole in the plate which was abused and tortured when the hole was punched, was eaten away and grooved some by the acids in the feed water. These same acids, of course, attacked the material of my body and a slow but positive action began, not only on my body but on that of nearly all the other staybolts, and we became thinner and thinner at certain points, and I knew it would be only a question of time until some of us would give way. When I started in service, the steam pressure carried on the boiler was 100 lbs. per sq. in. and all was lovely then. We bolts were spaced 5 in. by 6 in. or 30 sq. in. to the bolt; that was 3,000 lbs. to the sq. in. and we could stand that load without any trouble. But the boiler changed hands several times and some of the fool firemen insisted on overloading the safety valve; that increased our load considerably at times.

Newe: Was the safety valve overloaded when the accident occurred?

Olde: Oh, no! Not a pound. Myself and seven of my nearby companions became reduced in body by corrosion until we were approximately 1/4 in. in diameter. And although the boiler was nearly twenty years old, they still carried 100 lb. pressure at times, and the load of 3,000 lb. each was too much for us and when we reached our limit of resistance, we had to let go. When eight of us let go at the same time, the side sheet bulged out, pulled over the heads of many of the other bolts, then tore up along the sides and stripped loose from most of the crown bolts and ripped along one side and was blown downward. The escaping steam and hot water scalded three men, causing their death, and the force of the explosion blew the boiler in the air and about fifty yards away.

Newe: That was tough on the men and harder on their families. But I've been turning over a few figures in my mind and I find that if your body was reduced to approximately 1/4 in., or a cross-sectional area of .049 sq. in., the load on you at 100 lb. steam pressure would equal about 61,224 lbs. per sq. in. or what was about the tensile strength limit of the material. No margin, no factor of safety. Surely, failure was inevitable. Such conditions are certainly to be condemned. But tell me, was the boiler never inspected during all the years that your body was wasting by corrosion?

Olde: The only inspections consisted of the "once overs" by country mechanics, who usually looked over the outside and in the furnace door, and several times they were well pleased with the appearance of the boiler because it had a heavy coat of tar paint. Had anyone looked in the handholes with a light placed inside the boiler during the last ten years they could have detected our badly wasted condition, and would probably have prevented the loss of human life.

Newe: Well, my story is shorter than yours. My time of service was mighty short; in fact, I cannot claim to have given any service, as I was found defective before the boiler had a fire put in it. The material of which I was made was of good quality, but the heating of it was not just right, and when the round rod was rolled a portion of it was not properly welded, in other words, I was not homogenous. The imperfection did not show on the surface of the rod, and of course it got by the rolling-mill inspector. The material was compact enough to stand threading and still not show defective. Finally, I was screwed into the side of a large locomotive boiler — one end in the side sheet of the furnace, the other in the wagon top or wrapper sheet. This caused the defect in my body to become more pronounced. When the material at the ends was upset or beaded over, the shocks caused by the blows of the hammer split me practically from end to end. The separation of material was not noticeable at the ends and while I was seriously split throughout inside the boiler, this could not be seen, and I thought I was booked to give service although defective. I missed my guess, however, as you will see. The boiler was of a standard requiring the ends of the staybolts to be drilled. So there was a 3/16 in. hole drilled in the outer end, extending 1/2 in. inside the inner surface of the outer plate. The standard specification called for a hydrostatic pressure test of 1½ times the allowable working pressure. When this test was put on the boiler, the inspector was on the job and discovered very slight leakage through the telltale hole. He ordered me taken out, and when removed I was found as you see me, split from end to end, defective, and detected by modern inspection methods. So you can see, *Olde Staybolt*, there are modern methods of making steam boilers safe.

Moral: Steam boilers should be designed, constructed and operated under modern safety standards.—*from "Power."*

Explosion of a Fireless Locomotive.

One type of locomotive that is used in industries where the presence of an open fire would be dangerous is that which uses a pressure tank containing a large amount of water which is heated to a high degree and raised to a correspondingly high pressure by the admittance of live steam at a charging station. The water acts as a reservoir for the heat, and steam is given off at a continuously decreasing pressure as the locomotive is used. Such engines are frequently known as "fireless locomotives" in distinction to "compressed air locomotives." That they may become dangerous is well shown by an article which appeared in the Austrian publication, *Zeitschrift der Dampfkesseluntersuchungs-und Versicherungs-Gesellschaft a G.* under date of August, 1921, which gives an account of the explosion of one of these locomotives.

The boiler of this locomotive, which was built in 1915, was 67″ in diameter and 13½ ft. long and was designed for a maximum pressure of 190 lbs. On July 14, 1921, it was being charged from a boiler built for 260 lbs. and the driver had just given the signal to stop charging when the head of the boiler opposite the cab tore off circumferentially in the turn of the flange. The shell and the other head of the boiler were thrown a distance of 1550 ft., in which flight it is said the boiler struck the earth and the roofs of buildings six times. The driver of the locomotive was instantly killed.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

HARTFORD, APRIL, 1922.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

MINIATURE boilers, by which we mean boilers less than 18 inches in diameter, have long been popularly classed as harmless. Many have said that they would not explode and then, not having the strength of their convictions, have followed this by the remark that if one did explode it could do no damage.

The fallacy of such statements can easily be proved by mathematical calculation. Proof of this nature, however, is not always convincing to the exponent of these small boilers and a practical demonstration becomes necessary. Such a demonstration was given not long ago by a boiler 18 inches in diameter and 36 inches long located in a clothes pressing establishment at Thomson, Georgia. One man was scalded by the escaping steam and boiling water and several others also were injured. All the seams of this boiler were welded and the explosion resulted from the failure of a seam near the bottom of the furnace, hurling the shell through three floors of the building and into the air a distance of about fifty feet.

It is reported that this boiler was equipped with a 1″ safety valve which was said to operate at 60 lbs. pressure. The operator stated that the gauge showed 38 lbs. pressure at the time of the accident. The conclusion is that the safety valve was set at a higher pressure than was intended, the pressure gauge was incorrect, or the construction was improper and inadequate for the pressure. The welded seams would indicate that the last mentioned cause was most likely the correct one.

The Boiler Code Committee of The American Society of Mechanical Engineers is now at work upon a Code for Miniature Boilers. We most heartily commend this action in the interest of safety for life and property.

Personal.

E. Sidney Berry.

J. J. Graham.

Halsey Stevens.

Photos by Bachrach.

At a meeting of the Board of Directors of The Hartford Steam Boiler Inspection and Insurance Company, held on March 1, 1922, Mr. E. Sidney Berry was elected Second Vice President and General Counsel, Mr. J. J. Graham an Assistant Secretary and Mr. Halsey Stevens an Assistant Secretary.

Mr. Berry came with the Company on April 1st, 1908. Previous to that time he was identified for many years with the Employers'

Liability Assurance Corporation, Ltd. and the Ætna Life Insurance Company. Appointed first as Counsel to The Hartford Steam Boiler Inspection and Insurance Company, he later, in November 1916, was advanced to the position of Assistant Secretary. In his present position of Second Vice President he retains the office of General Counsel to the Company.

Mr. Graham, after several years' experience in the engineering field, first came with this Company in January 1906 as an inspector in the Cleveland Department. In 1908 he was made a special agent and in April 1913 was transferred to Pittsburgh as Manager of that department. In 1917 he was appointed Superintendent of Agencies with headquarters in Hartford. As Assistant Secretary he will continue in his oversight of the agencies.

Mr. Halsey Stevens has been with the Company for thirty-three years having entered its employ in 1889. He has handled all branches of the records department and in 1916 he was appointed to the position of chief clerk. As Assistant Secretary he will be afforded a broader field of activity and responsibility.

Joseph McMurray.

Mr. Joseph McMurray, who is connected with The Hartford Steam Boiler Inspection and Insurance Company as a Special Agent in the New York Department, recently completed his fiftieth year of continuous service in its employ. In observance of the occasion, Mr. McMurray was tendered a dinner and theatre party by his associates in the New York Department.

Mr. McMurray was born in October, 1844. During the Civil War he served as a member of the Thirteenth Regiment of Brooklyn and just previous to his coming with this Company, he was connected with Hardner & Ripley, engine builders, of New York City. He started as an inspector with this Company in January 1872 and was appointed a Special Agent in 1905.

Long service with the Company seems to be a habit in the McMurray family for Robert K. McMurray, a brother of Special Agent McMurray, entered the service of the Company in 1867 and served continuously as Chief Inspector of the New York Department until his death in 1910.

The following appointments were made to the Home Office Staff on March 1st: Charles E. Ripley, Superintendent, Hartford Department; Charles F. Dow, Superintendent Underwriting Department; and Alfred W. Mucklow, Superintendent, Special Risks Department.

Mr. Ripley has been with this Company since April 1887 and has been in charge of the policy writing department of the Home Office for many years.

Mr. Dow entered the employ of the Company in March 1896 and in recent years has been in charge of the underwriting review.

Mr. Mucklow, whose length of service with the Company dates from June 1898 has been for a long time in charge of a branch of work which in recent years has developed into a Special Risk Department.

Obituary.

Henry A. Baumhart.

HENRY A. BAUMHART.

Henry A. Baumhart, Manager of the Cleveland Department of the Hartford Steam Boiler Inspection & Insurance Company, died at his home in Vermilion, Ohio, on March 17th, 1922, after an illness of about three weeks.

Mr. Baumhart was born April 25th, 1862. After a period of service as an engineer on the Great Lakes he entered the employ of this company on July 1st, 1891. In April, 1892, he was made Chief Inspector of the Cleveland Department and on October 31st, 1907, he was appointed Manager of that Department.

Among the boiler manufacturers, engineers and steam users throughout the Middle West Mr. Baumhart had a wide acquaintance and he was universally liked by all with whom he came in contact. He had a wide experience in boiler engineering and his advice was constantly sought by those in the power plant field. On the Ohio Board of Boiler Rules he took an active part and was, for a number of years, its Vice-Chairman. He was also a member of the Cleveland Engineering Society, and of the Cleveland Chamber of Commerce.

Mr. Baumhart leaves a wife and three daughters and to them we desire to express our deepest sympathy. In his death, the company has lost a most valuable man. Rarely is the combination found, that was his, of such a valuable fund of information, excutive ability, and genial disposition.

The death of Mr. H. A. Baumhart, manager of the Cleveland department of this Company, was a great shock to his business friends as well as to his family. The esteem in which he was held prompts me to make a statement of our appreciation of his sterling qualities.

Mr. Baumhart was a very modest man, and underestimated the importance of his achievements. His judgment was sound, and his opinion upon methods of construction and operation of boilers was much sought and generously given. His influence with boiler manufacturers and boiler owners has had much to do with improved workmanship and safer use of steam boilers, not only within the district of his department, but throughout the country. During the World War, he was summoned to Washington from time to time by the Government for consultation and advice concerning a large order of steam boilers for use by the American Expeditionary Forces in France. This service to the Government was rendered as long as needed, and resulted in selecting the correct type of boilers and expediting the shipment to foreign shores.

While acting as chief inspector or manager, Mr. Baumhart met in a satisfactory manner every demand and emergency that arose in his office. He was honest in his convictions and loyal to his Company, possessing high ideals which he lived up to in his everyday life. His fine character should be an inspiration to those who knew him, and he will long be remembered. As an evidence of the esteem and good will in which he was universally held, friends from Cincinnati, Columbus, Toledo, Erie, Pittsburgh and other distant points attended the funeral services held at Vermilion, Ohio. This spontaneous expression was very touching, and gratified all of Mr. Baumhart's family and business associates.

Chas. S. Blake,
President.

Thomas E. Shears.

Mr. Thomas E. Shears, former Manager and Chief Inspector of the Denver Department of The Hartford Steam Boiler Inspection & Insurance Company, died on Sunday, February 19, 1922, at the age of seventy years.

Mr. Shears was in the service of this company for almost thirty-four years, having entered its employ on May 15th, 1888. After serving in the inspection department for more than nineteen years — during a large part of this time he filled the position of Chief Inspector — he was appointed Manager and Chief Inspector of the Denver Department. In this capacity he served until June 1, 1919 when he retired from active service on account of ill health.

Announcement is made of the removal on February 20th, 1922, of the office of the Philadelphia Branch of this company from the former location at 142 South Fourth Street to 429 Walnut Street, Philadelphia, Pa. The new building, which is owned by this company, will afford space which heretofore has not been available for the rapidly growing business of the company in the vicinity of Philadelphia.

Caught in the Separator.

AWOKE IN THE AIR.

Haynesville, La., Jan. 22 — J. D. Stewart, member of a drill crew in the oil field here, while asleep near a boiler suddenly awoke to find himself sailing over the tree top astride the exploded boiler. He landed in a tree 165 feet away, with one leg broken and several scalp wounds. Dan Kelly, fireman, was injured painfully.— *Commercial Appeal.*

Oh that Langley were alive that he might see how the science of aviation has progressed!

A LETTER.

Dear Sirs:—

Will you kindly advise me what factor of safety a licensed operator of Steam Engines and Boilers would be with relations to accident insurance on damage and destruction.

Will you also kindly forward to me such literature and booklets of photographs of explosions that would be helpful to me in conducting an educational campaign among Engineers.

Thanking you for the above, I am,

Very truly yours,

Sounds like a runaway flywheel, doesn't it?

EXTRACT FROM AN INSPECTOR'S REPORT.

"The safety valve of the boiler at B....., K..... is of the lever type ½″ size with a lever 8″ long. The valve seat has been leaking and tied on to the end of the lever was one fire brick, one automobile jack, one spark plug and one staple 5″ long.

Probably there was nothing more available.

IT WOULDN'T FIT.

"Did ye bring home that pane of glass for the kitchen windy, Pat?"

"Oi did not. Oi was after a twoilve by fourteen, and the only size they had was fourteen by twoilve."

"Ye fool, why didn't ye get it? Ye could put it in sideways, couldn't ye?"— *Exchange.*

Summary of Inspectors' Work for 1921.

Number of visits of inspection made	230,640
Total number of boilers examined	449,685
Number inspected internally	174,102
Number tested by hydrostatic pressure	11,273
Number of boilers found to be uninsurable	768
Number of shop boilers inspected	10,163
Number of fly wheels inspected	49,075
Number of premises where pipe lines were inspected	14,136

SUMMARY OF DEFECTS DISCOVERED.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	38,127	1,952
Cases of adhering scale	49,829	1,914
Cases of grooving	2,259	246
Cases of internal corrosion	24,779	1,041
Cases of external corrosion	13,471	1,119
Cases of defective bracing	919	282
Cases of defective staybolting	3,311	577
Settings defective	10,078	1,036
Fractured plates and heads	4,181	670
Burned plates	3,825	549
Laminated plates	486	73
Cases of defective riveting	1,279	324
Cases of leakage around tubes	15,556	2,816
Cases of defective tubes or flues	21,416	7,317
Cases of leakage at seams	5,960	518
Water gauges defective	5,414	979
Blow-offs defective	5,739	1,706
Cases of low water	426	133
Safety-valves overloaded	1,307	393
Safety-valves defective	2,522	491
Pressure gauges defective	8,269	705
Boilers without pressure gauges	835	117
Miscellaneous defects	8,299	1,678
Total	226,087	26,636

GRAND TOTAL OF THE INSPECTOR'S WORK FROM THE TIME THE COMPANY BEGAN BUSINESS, TO JANUARY 1, 1921.

Visits of inspection made	5,171,634
Whole number of inspections (both internal and external)	10,232,788
Complete internal inspections	4,006,771
Boilers tested by hydrostatic pressure	387,762
Total number of boilers condemned	29,746
Total number of defects discovered	5,718,511
Total number of dangerous defects discovered	630,319

FLYWHEEL EXPLOSIONS DURING 1921.

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	Jan.	14	Flywheel exploded			Pavilion Natural Gas. Co.	Gas Co.	Rochester, N. Y.
2	Jan.	14	Flywheel exploded			Mullen Bros.	Paper Mill	St. Joseph, Mich.
3	Jan.	19	6 ft. flywheel exploded			Underwood Typewriter Co.	Typewriters	Hartford, Conn.
4	Jan.	21	7,000 lb. flywheel exploded $17,000 damage			Holden Paper Co.	Paper Mill	New Windsor, N.Y.
5	Feb.	3	Flywheel exploded			Emerson Carey Fibre Products Co.	Strawboard	Hutchinson, Kan.
6	Feb.	5	Pulley burst			Great West Mill & Elevator Co.	Flour Mill	Amarillo, Tex.
7	Feb.	24	10 ft. gear wheel on marine railway exploded			Norfolk Shipbuilding & Drydock Co.	Shipyard	Brambleton, Va.
8	Feb. Mar.	26	Flywheel exploded			Thompson-Ford Lumber Co.	Lumber Mill	Kelso, Wash.
9	Mar.	7	Two ton flywheel exploded	1		Southern Countries Gas Co.	Gas Co.	Long Beach, Cal.
10	Mar.	13	12 ft. flywheel exploded	1		Town of Hobart	Power Plant	Hobart Ind.
11	Mar.	22	14 ft. flywheel exploded, damage $12,000	1	1	Watauga Extract Co.	Extracts	Elizabethton, Tenn.
12		25	58″ pulley exploded			Thos. L. Leedom & Co.	Carpet Mill	Bristol, Pa.
13	Apr.	1	20 ft. flywheel exploded			Madison Light & Railway Co.	Power Station	Madison, Ind.
14	Apr.	1	78″ flywheel exploded			Hilgard Lumber Co.	Lumber Mill	Selma, Ala.
15	Apr.	3	Flywheel exploded, $12,000 damage			Home Oil Mill.	Oil Press	Albany, Ala.
16	Apr.	7	18 ft. flywheel exploded		2	Trippensee Mfg. Co.	Mfg. Plant	Detroit, Mich.
17	Apr.	27	Flywheel exploded		2		Mfg. Plant	Causton Bluff, Ga.
18	May	3	Turbine blower exploded	1	1	Kings County Lighting Co.	Power Station	Brooklyn, N. Y.
19	May	16	50″ pulley burst			Morehead Cotton Mills Co.	Cotton Mills	Spray, N. C.
20	May	23	15 ft. flywheel exploded damage $6,000			Osgood & Blodgett Mfg. Co.	Mfg. Plant	St. Paul, Minn.
21	May	26	Pulley on sawmill burst	1		Everett Merida	Farm	Nashville, Ind.
22	May	27	72″ flywheel exploded wrecking several pulleys			Ironside Board Corp.	Paper Mill	Norwich, Conn.
23	May	30	Flywheel exploded, damage $7,000			Fernwood Lumber Co.	Lumber Mill	Fernwood, Miss.
24	June	2	Flywheel of auto engine exploded		2	Wm. Foley	Automobile	Lowell, Mass.
25	June	30	Two 78″ rope drive wheels burst			Leaksville Cotton Mills	Cotton Mill	Spray, N. C.

26	Aug.	2	Hydroextractor exploded	3	2	Standard Silk Dyeing Co.	Silk Dyeing	Paterson, N. J.
27	Aug.	3	Flywheel exploded, damage $10,000			Anderson-Tully Co.	Box Factory	Memphis, Tenn.
28	Aug.	7	2,000 lb. flywheel exploded			C. B. & Q. Railway	Machine Shop	Centerville, Ia.
29	Aug.	14	Flywheel exploded	1		River Rasin Paper Co.	Paper Mill	Monroe, Mich.
30	Aug.	30	10 ft. flywheel exploded		1	Anderson-Tully Co.	Veneer Mfgrs.	Memphis, Tenn.
31	Sept.	2	Hydroextractor exploded		1	American Thread Co.	Thread Mill	Holyoke, Mass.
32	Sept.	13	Flywheel on ensilage cutter exploded		1	Hans Anderson	Farm	Exira, Ia.
33	Sept.	14	10 ft. flywheel exploded			Commonwealth Service Co. of Mena	Power Station	Mena, Ark.
34	Sept.	17	Hydroextractor exploded		1	American Thread Co.	Thread Mill	Holyoke, Mass.
35	Sept.	19	Flywheel on auto engine exploded				Automobile	Galveston, Tex.
36	Sept.	28	9 ft. flywheel exploded			Liberty Clay Products Co.	Clay Products	Volant, Pa.
37	Sept.	28	Flywheel exploded, $2,000 damage				Electric Lgt. Plant	Phillipsburg, Kan.
38	Oct.	8	Four ton flywheel on engine driven generator exploded			Ingle Mine, No. 7		Ayreshire, Ind.
39	Oct.	10	Flywheel on gas engine broke		1	Hoopeston Ice & Cold Storage Co.	Cold Storage	Hoopeston, Ill.
40	Oct.	15	Flywheel on traction engine exploded	1		Arcade Rushlow	Traction Engine	St. Albans, Vt.
41	Oct.	17	Hydroextractor exploded	1	1	Franklin County Children's Home		Columbus, Ohio.
42	Oct.	17	Hydroextractor exploded		1	Atlas Laundry	Laundry	San Francisco, Cal.
43	Nov.	3	Idler pulley on rolling mill broke			Pittsburg Steel Co.	Steel Mill	Monessen, Pa.
44	Nov.	12	Flywheel of auto engine exploded	1	2	C. A. Pullian	Automobile	Bluefield, West Va.
45	Nov.	16	Flywheel exploded	1		J. T. Davis	Cotton Gin	Mansfield, Tenn.
46	Dec.	15	Flywheel exploded			Rockwell Mfg. Co.		Camden, Ark.
47	Dec.	16	Flywheel on feed grinder exploded	1		Rowley Farm	Farm	Franksville, Wis.
48	Dec.	28	Flywheel on ensilage cutter exploded	1		Martin Appolo	Farm	Paxinos, Pa.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1922

Capital Stock, . . $2,000,000.00

ASSETS

Cash in offices and banks	$492,329.45
Real Estate	150,000.00
Mortgage and collateral loans	1,673,850.00
Bonds and stocks	6,429,307.52
Premiums in course of collection	766,619.61
Interest Accrued	120,981.61
Total assets	$9,633,088.19

LIABILITIES

Reserve for unearned premiums		$4,602,639.11
Reserve for losses		213,814.87
Reserve for taxes and other contingencies		396,621.24
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,420,012.97	
Surplus to Policy-holders		**$4,420,012.97**
Total liabilities		$9,633,088.19

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President and General Counsel.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.

BOARD OF DIRECTORS

ATWOOD COLLINS, President, Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Bank, Hartford, Conn.
MORGAN B. BRAINARD, Vice-Pres. and Treasurer, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
FRANCIS T. MAXWELL, President, The Hockanum Mills Company, Rockville, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Ass't Treas., Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Company.
SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.

Incorporated 1866.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLYWHEEL EXPLOSIONS AND ENGINE BREAKAGE

Department.	Representatives
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, CT., 405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. E. Mason Parry, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'l'v'd	J. F. Criswell, Manager. P. M. Murray, Ass't Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	H. A. Baumhart, Manager. L. T. Gregg, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J H. Chesnutt, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, General Agent. E. Mason Parry, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnett, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickham, Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrott Bldg.	Geo. S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	McCargar, Bates & Lively, Gen'l Agents. C. B. Paddock, Chief Inspector.
SEATTLE, Wash., 540 New York Block	C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.

CARNEGIE LIBRAR
PITTSBURGH, PA

A DOZEN DON'TS FOR THE BOILER ROOM

1 — DON'T fail to **blow down water column** and **gauge glass** on each boiler when going on duty and several times while on duty, nor fail to **try** the **gauge cocks frequently** to be sure the level of the water in the gauge glass is correct.

2 — DON'T neglect to **test all safety valves** each day to be sure they are not stuck. Test-levers placed on pop valves are for this purpose and they should be kept in place.

3 — DON'T fail to **report** any **leakage or unusual conditions** to someone in authority and request that they advise the insurance inspector.

4 — DON'T connect a boiler to the steam main until the **pressure in the boiler** is the **same** or not more than three pounds above the pressure in the main.

5 — DON'T forget that a badly **scaled boiler** is **unsafe** and will make your work harder in keeping up steam pressure and that the **least amount of oil** in a boiler may become a **source of danger.**

6 — DON'T **attempt to make repairs** to a boiler or steam piping while **under pressure.** Take them out of service for such work and if the boiler is out of use for more than a few days do not fail to drain and thoroughly dry it out.

7 — DON'T **be careless** when you **blow down** a boiler. Be sure that the water discharged **can do no damage to any person. Open** and **close** the blow-off **valves slowly** and **stay on the job** from start to finish.

8 — DON'T **neglect** the **pressure gauge** or fail to have it **tested.** Sometime it may be wrong.

9 — DON'T pull your fire if you get **low water.** Cover it with **wet ashes** or a **heavy layer of coal,** close the ash pit door and the damper and open the furnace door. Keep the engine or other steam using apparatus operating until the pressure goes down. Do not feed any water to the boiler until the pressure is below 25 pounds and you have satisfied yourself that no damage has been done by overheating.

10 — DON'T **try to raise steam** in a **cold boiler** too quickly. You may **ruin it.**

11 — DON'T close up a boiler after cleaning before you are sure that all tools, waste, etc., are removed from it.

12 — DON'T **depend on others to see that everything is all right. See to it yourself.**

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, CONNECTICUT

Form 476
Dec. 1921

Copies of the above, on a sheet 11″ x 14″, suitable for posting in the boiler room, may be obtained by addressing

THE HARTFORD STEAM BOILER
INSPECTION and INSURANCE CO.

HARTFORD CONNECTICUT

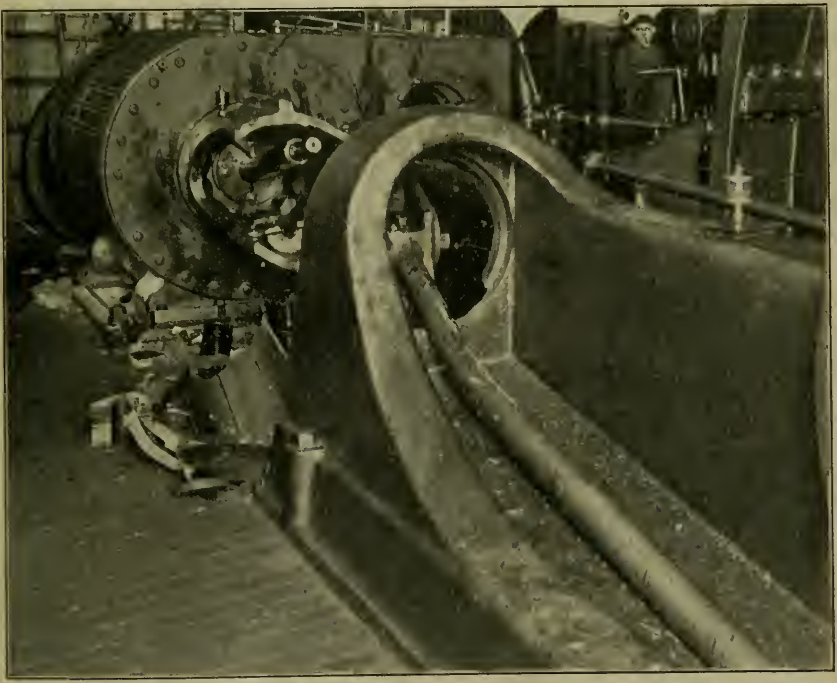
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIV. HARTFORD, CONN., JULY, 1922. No. 3

COPYRIGHT, 1922, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



A RECENT ENGINE WRECK.

An Engine Wreck of Large Proportions.

DEFECTS in the condenser piping had been discovered and repairs made; the engine had been given a test run and everything found satisfactory; orders had been given to stop the engine and the throttle valve had just been closed when a terrific crash occurred and one side of the big cross compound engine was all but a total wreck. Within a small fraction of a second the engine, which only an instant before was running quietly and smoothly, was rendered useless and a repair bill of thousands of dollars made necessary.

The accident — the results of which are shown in the illustration on the front cover — occurred in a large paper mill and was brought about by a hazard which is ever present in the operation of an engine, namely, the entrapping of water in the cylinder. In the present instance the engine was operated in conjunction with a barometric jet condenser and the trouble resulted from failure to shut off the injection water and to open the atmospheric relief valve before shutting off the steam to the engine. Inasmuch as the throttle was closed first, before the vacuum in the pipe to the condenser had been destroyed, a large body of water was drawn back to the low pressure cylinder and caught between the crank end of the cylinder and the piston. As the engine was still travelling at a fair rate of speed there was sufficient energy in the large heavy flywheel and other moving parts of the engine to break the crosshead at the point where the piston rod is connected to it. At the same time, the guide barrel or crosshead slide was ruptured. This occurred near the end of the forward stroke of the engine and on the return stroke the crosshead caught under the end of the piston rod, bent it upward and completed the breaking of the guide barrel. The shock of this blow also bent the connecting rod, threw the twelve inch shaft 1/16″ out of true and cracked the massive iron frame almost entirely in two. The cylinder also suffered damage in that breaks occurred in the bridges of the steam passages and in the supporting feet. Fortunately for the owners, however, a Hartford Engine Policy was in effect and protection against financial loss was assured.

Saving the Coal Pile.

IN the "good old days" when steam coal cost only three or four dollars a ton, and the plant superintendent knew so little of power plant operation that he would not have recognized a British Thermal Unit if he had met one on the street, there was less incentive to conserve the coal pile than there is today with our high priced power fuel.

Saving of coal may result from proper handling of coal in storage or from better utilization in the power plant. While, without question, the losses of coal by poor power plant operation are generally much greater than the losses of coal in storage, yet the latter may under some conditions amount to quite a sum of money in a year and should be given careful attention. Much has been written about keeping up the power plant efficiency but little about losses in storage.

The losses which occur in stored coal are caused by weathering or by spontaneous combustion. The losses from weathering are comparatively small, amounting to not over 1.2 per cent. of the heat value of the coal in the first year or 2.1 per cent. in two years, although some Wyoming coal has shown a somewhat greater loss than this.*

The losses due to spontaneous combustion vary over a wide range according to the kind of coal stored and the methods used in its storage. Some coals are much more subject to spontaneous combustion than others, but, according to H. H. Stoek, "Although practically every kind of bituminous coal has been stored without spontaneous combustion, yet under certain conditions spontaneous combustion has occurred with practically every kind of coal stored." †

It will be well therefore to consider the causes and conditions which promote spontaneous combustion.

Causes of Spontaneous Combustion.

Sulphur, which occurs in coal largely in the form of a sulphur-iron compound commonly known as pyrites, was at one time thought to be the main cause of spontaneous combustion in coal piles but is now considered a contributory cause rather than the main cause. If pyrites absorb oxygen in the coal pile, suphuric acid is formed and heat will be generated, and further, this heat and the swelling of lumps of

---

Acknowledgment is made to Univ. of Ill. Engineering Experiment Station, Bulletin No. 116 for some data used in this article.

* Bur. Mines Bulletin No. 136 — Deterioration of the Heating Value of Coal During Storage, Porter & Ovitz, 1917.

† The Storage of Bituminous Coal, H. H. Stoek, University of Illinois, Eng. Exp. Sta. Circular No. 6, 1918.

coal due to oxidation of the sulphur, will result in the breaking up of lump coal into fines or slack.

Oxidation of the carbonaceous matter of the coal is going on at all times and temperatures but oxidation progresses faster at higher temperatures. From this it is evident that if the heat resulting from this oxidation could be carried away as fast as generated, then the temperature of the pile would not rise appreciably and no spontaneous combustion would take place. It has not been found practical, however, to ventilate large piles successfully because the presence of fine coal or slack interferes with the successful operation of the various methods of coal pile ventilation that have been tried. No doubt, ventilation by driving pipes 3 to 4 inches in diameter with holes in their sides, into coal piles, has helped cool many coal piles but with other varieties of coals this method will allow air to penetrate into the pile resulting in an increase in oxidation and ignition of the coal.

Many cases of spontaneous combustion have been started from piling coal in contact with hot pipes and surfaces such as steam pipes, hot water heaters, bases of chimneys, etc. This is poor practice, for as noted above, the oxidation of coal substances is increased by higher temperatures and the temperature of steam pipes is high enough to start trouble in many coal piles which might not of themselves go wrong.

The method used in placing the coal in storage affects its liability to spontaneous combustion. This is largely the result of the separation or segregation of the different sized pieces which is greater when coal is piled one load on top of the other until a high cone shaped pile is formed. With this method of piling the coal the lighter or smaller sized pieces stay near the top while the larger pieces roll down the side of the pile and accumulate at the bottom. The bottom is then more porous than the top, and air can penetrate into the center of the pile and promote oxidation, while the heated gases rise higher into the interior of the pile, from which they cannot escape. The final result is likely to be a raising of the temperature up to a point where spontaneous combustion starts. For the same reason coal should not be piled on a cinder or other porous bed.

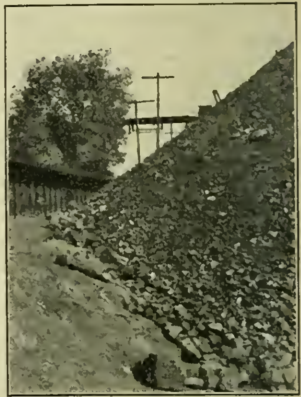


Fig. 1.

This separation of the different size pieces of coal is well illustrated in Fig. 1 in which it will be noticed that the large lumps are mostly at the bottom of the pile, resulting in a porous condition there, favorable to spontaneous combustion.

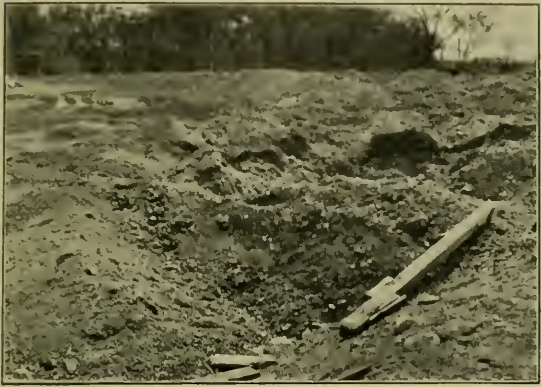


Fig. 2.

If coal is placed in storage in layers, the lumps separate from the fines to a much less extent than when the coal is piled as outlined above, and the mixture of "fines" and lumps will keep air from the center of the pile. If the coal is all lump then there is usually ventilation enough through the pile to keep it cool and little likelihood of spontaneous combustion unless the coal is of a type which slacks down in storage, in which case the conditions will be similar, after awhile, to the pile mentioned above where the coarse coal was at the bottom and the fine coal on top. Piles of fine coal alone are less liable to spontaneous combustion, other conditions being equal, than a mixture of coarse and fine.

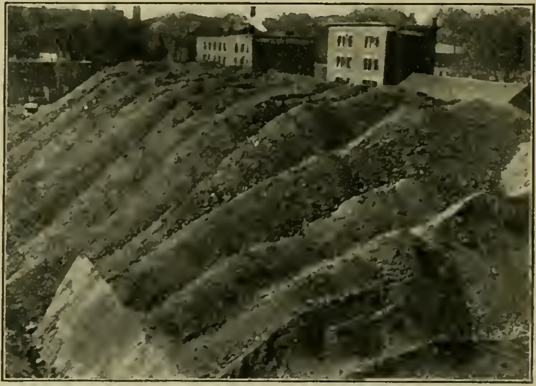


Fig. 3.

A coal known to be liable to spontaneous combustion should be stored in as low piles as practicable and arranged so that it can be moved as promptly and easily as conditions will permit.

If ground is available to spread out the stored coal in low piles, not over 10 feet deep, as illustrated by Fig. 2, the danger of spontaneous combustion is materially reduced. Unfortunately, limited space often necessitates the storing of coal in high piles as shown in

Fig 3, the pile here shown being about 30 ft. high. In this instance, considerable trouble has been experienced with spontaneous combustion and this has undoubtedly been due to the height of the pile.

It has been found poor practice to store new coal on top of old coal because this seems to give trouble at the junction of the new and old piles.

Spontaneous combustion has been started by the presence of wood, rags and other extraneous materials in the coal pile and it will pay to see that nothing is allowed to get into the storage pile that has a lower igniting point than the coal itself. Old lumber such as boards, boxes, etc., besides having a lower igniting point than coal itself, contribute another factor that may aid spontaneous combustion, namely, the formation of pockets of air which may be trapped by boxes and under boards, this condition as explained above assisting in the oxidation of the carbonaceous matter of the coal. For example, if a piece of timber such as is shown in the lower right foreground of Fig. 2 was left where it is seen and more coal piled above it, it is evident that a pocket of air would be enclosed beneath this timber and the probability of trouble increased. As long as it remains on the top of the pile, the timber would not become heated and would do no harm.

DETECTION OF SPONTANEOUS COMBUSTION.

We have discussed some of the causes of and conditions assisting spontaneous combustion and we will now consider some methods of detecting trouble of this kind, before fire has actually burned through to the air.

The external indications which give evidence of spontaneous combustion are the appearance of steam above the pile, the presence of an odor of a tarry or sulphurous mixture due to the distillation of some of the coal's volatile matter and the oxidation of pyrites, and the melting of snow in spots which may indicate local heating in the pile. If attention is given to these indications regularly, much loss and hard work later on may be saved.

When indications are shown of spontaneous combustion, an examination should be made without delay to determine the source of the trouble. This may be done by pushing or driving an iron bar such as a poker, down into the pile in the vicinity where trouble is indicated and feeling of the end of the bar after withdrawal to see if it is hot to the touch. This is a crude method but applicable to plants which have no thermometer or other means of determining temperatures.

Where coal is stored in large quantities a regular inspection of the coal pile should be made and facilities provided to obtain temperatures. The temperatures may be taken by means of thermometers lowered in ¾″ or 1″ pipes driven into the pile. Whether these pipes shall be left in the pile or not will depend on how long it is expected to keep the coal in storage. If only for a short while it may be sufficient to remove the pipe for each reading, but where piles are to be maintained for long periods, such as reserve piles, it is desirable that pipes be driven into the pile at regular spaced intervals of say 10 feet each way. Scrapped pipes of ¾″ or 1″ size are suitable and should be plugged at the lower end to keep air from circulating through them. An armored maximum reading thermometer is best for taking readings, although in some cases conditions may warrant the purchase of recording thermometers or pyrometers.

It has been observed in several instances that stored coal that is heating shows the hottest point from 6 to 8 ft. from the surface. Therefore this level should receive extra care on inspection with the thermometer.

Readings should be taken at various depths in the pipes to determine the hottest points and careful record should be kept of all readings and their location and depth for comparison with later readings at the same points to see if there is any rise in temperature. Readings should be taken every few days over the whole pile and if any spot shows signs of heating it should be observed oftener, say twice a day, for much labor may be saved if trouble is located before the temperature gets high enough to ignite the pile.

Prevention of Spontaneous Combustion.

If the methods outlined above are conscientiously followed, any tendency for the pile to heat, from any cause whatever, should be detected before material damage is done and the next step to consider is what should be done to take care of any heating which thermometer readings indicate is starting in the pile of stored coal.

When readings taken in the regular temperature inspection pipes indicate a rise in temperature it may be well to drive temporary pipes around the suspected area and between the regular spaced pipes and locate by temperature reading the exact spot which is the source of the heating. Then if the temperature is not over 140°, vent pipes made of old boiler tubes or pipes 3 to 4 inches in diameter may be driven into the pile in several places near the hot point.

The temperature of the coal pile as determined by inspection with the thermometer should be given the following attention.

1 — A slow rise in temperature need not cause alarm unless it approaches 140° F.

2 — A rapid rise in temperature requires close attention and frequent readings to watch for ignition of the coal.

3 — At 140° F. the coal pile should be regarded with suspicion and the temperature carefully watched.

4 — A temperature of 160° F. will warrant the removal of at least some of the coal over the hot spot to permit an easier escape for the heat. If, say the upper two or three feet of coal are removed, the hot gases may escape fast enough from the pile at this spot so that no further treatment will be necessary to cool down the coal.

5 — Coal begins to smoke at about 180° F. Therefore, it should be moved and cooled before this temperature is reached.

It has been observed that spontaneous combustion generally occurs within three months after storing and if no sign of heating has occurred by this time, the probability of firing is greatly reduced.

The lower end of the pipes or tubes should be flattened to a slit one-half inch wide both to keep coal out in driving and to let water drain out afterwards. Also holes should be punched in the sides of the vent pipe to permit heated gases to enter and escape through the pipe to the outside of the pile.

In some cases these pipes, by furnishing an escape for the hot gases as fast as formed, may ventilate the pile and cool it down. In other cases the effect may be just the opposite. That is to say, the entrance of air into the pile may increase the oxidation and raise the temperature faster than the vent pipes take the heat away.

The use of water as a means of overcoming heat in the interior of piled coal is not altogether successful. In the first place, the water is not sure to reach the spot where it might do some good. Water played onto the surface seldom penetrates far into the pile of coal as the fine coal fills up the space between the larger pieces, forming an impervious mass and, furthermore, what little water gets down in the hot coal is vaporized before it can cool the hottest spot.

It has also been observed in some cases that water promotes the chemical oxidation of the coal and pyrites, which results in more heating. Of course, if spontaneous combustion has progressed so far that the coal is actually fired, it may be necessary to use water to save damage to surrounding structures, but it is advisable to use water sparingly on the surface of a coal pile.

If water is used to control heating beneath the surface of piles, it will pay to provide a pipe nozzle long enough to drive down to the hot spot as located by the thermometer readings. This pipe should be provided with a pointed end for driving and with many openings placed in the general direction of a spiral in its sides. With this arrangement, when water is turned on it will be supplied in quantities sufficient to flood the affected area quickly so that the water which drains away will not be hot enough to carry heat and start trouble in another part of the pile. If such a pipe be attached by hose to a suitable supply of cold water under good pressure it may be effective in reaching and extinguishing the fire. If this is not effective then moving of the coal in the affected area is necessary, using water to cool the coal as it is moved.

Storage of coal completely under water overcomes both the deterioration due to weathering and danger from spontaneous combustion but the expense of installing such a system is prohibitive in many cases and in colder climates there is always the difficulty of retrieving the coal in the winter months from the frozen storage.

The depths to which coal may safely be piled for storage varies with different coals. Small graded coals may be piled 12 to 14 ft. deep, whereas washed, mixed coal should not be piled over 9 to 12 ft. deep. Of course, circumstances alter cases and with limited storage facilities it may be necessary to store coal in deeper piles, in which case it should be used sooner or turned over more frequently than a thinner pile.

Mechanical Refrigeration and Refrigerants.

ICE contains heat. So, in fact, do all bodies or substances with which we deal in everyday life. Certainly it is not hard to understand that a pound of ice at zero degrees temperature — ice, of course, can have its temperature reduced below the freezing point — has not as much heat in it as a pound of ice at 32°. The same thing holds true whenever reduction of the temperature of any substance takes place until a temperature of 460° below zero is reached when scientists say we have reached the limit for low temperature. It is theory only that contemplates this degree of low temperature for, as far as we know, it has never been actually reached by scientists, although it has been closely approached.

Refrigeration is merely a process of removing heat and by so doing the substance or body from which the heat is removed becomes colder or, in other words, has its temperature reduced. To melt ice, heat must be supplied from some source, and when a block of ice is placed in an ordinary domestic refrigerator this heat comes from the walls of the structure and the foodstuffs and containers that are placed therein. Consequently the foodstuffs are chilled.

Such is Mother Nature's homely method of refrigeration and by it the lowest temperature in the refrigerator is limited to the temperature of the melting ice which is 32°. Of course the actual temperature to which anything other than the ice is reduced is several degrees greater than 32. By mechanical refrigeration, however, several laws of nature have been set to work and by any one of the modern systems of refrigeration, temperatures below the freezing point of water may be reached. So much so in fact that mechanical refrigeration is used to manufacture ice which later is used in the domestic refrigerator, and the public today is undoubtedly more dependent upon "artificial" than upon "natural" ice.

What is the principle of mechanical refrigeration and what means are used to bring it about?

A most elementary apparatus for mechanical refrigeration would consist of an air compressor driven by a motor or engine, a cooler, and a cold storage room. This equipment is shown diagramatically in Fig. 1. Its method of operation would be as follows: The compressor raises the pressure of the air in the system but in so doing the temperature of the air also is increased. The high pressure air flows through the cooler which might consist of a coil of pipe over which cold water was allowed to flow. This would reduce the temperature of the air but leave it at a high pressure. When this cool, high pressure air reaches the cold storage room it is no longer closely con-

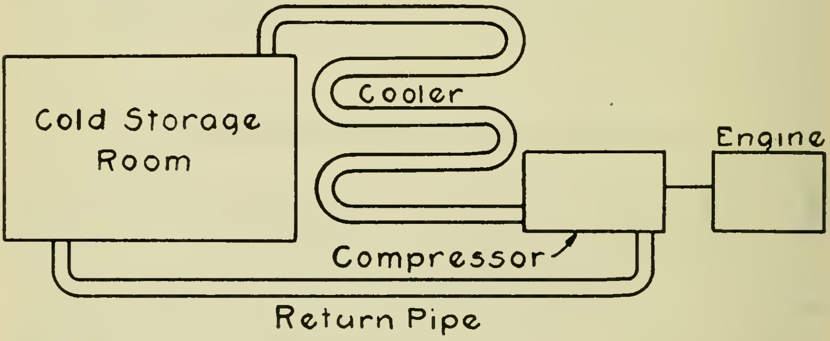


Fig. 6.

fined and its pressure is therefore greatly reduced. In so doing however — and this action is peculiar to all gases and vapors — its temperature also is greatly reduced and foodstuffs stored in the room are chilled or even frozen. In doing this, of course, the cold air becomes slightly warmed, but it may be drawn back to the compressor through the return pipe and again reduced to a low temperature, ready to make another passage through the cold storage room.

Aside from the fact that in most cases the refrigerating gas would be released into a series of pipes known as "expansion coils" instead of directly into the cold storage room, the process that has been described is the same in all essential details as the method used in practice and will serve as an illustration in the discussion of "refrigerants" or the mediums that are used in mechanical refrigeration of the compression type. In the case just described, air was the refrigerant and this gas, or mixture of gases, is in actual use in some refrigerating plants. It is not, however, the ideal medium.

Some of the points that must be considered in the selection of a refrigerant are (1) safety of persons, (2) deteriorating effect of refrigerant on the equipment, (3) pressures required for operation, and (4) .volume of refrigerant necessary or, what amounts to the same thing, size of the equipment.

Refrigeration, as has been stated before, is a process of removing heat. Though it is almost invariably desirable it is not necessarily the fact that the temperature of the refrigeration be less than 32°. Any system that cools is effecting refrigeration and the lower temperature is indeed often as high as 40° or 50° as, for instance, in cooling systems for theaters, hotels and office buildings.

Referring again to Fig. 1 and the description that was given in connection therewith, it will be noticed that the heat removed from articles placed in the cold storage room was raised to a higher temperature in the compressor and was then given to the cooling water. The refrigerating machine is then, in effect, a heat pump absorbing heat at a low temperature level and elevating it to a temperature at which it can readily be discharged to a heat removing medium which, almost invariably, is water. The lower the temperature of the water supply the less will be the effort expended in securing refrigeration.

Theoretically, any gas or vapor can be used as a refrigerant. Practically, however, we are limited to a comparatively small number such as air, ammonia gas, sulphur dioxide, carbon dioxide and water vapor. We shall discuss some of the advantages and disadvantages of each of these mediums and from this discussion it will be apparent why other possible refrigerants are not favored.

Air is a relatively safe medium to use and is therefore well adapted to installations where the escape of a noxious or poisonous gas might be extremely dangerous. Neither does air, if dry, have any deleterious effect on the equipment. With it, very low temperatures can be reached although practical difficulties, such as freezing of any water vapor which may be present and consequent interference with the operation of the machinery, may present themselves. The pressures need not necessarily be excessive so that danger of the bursting of pipes and vessels can be reduced. Air, however, is open to the objection that the refrigerating effect, or ability to remove heat, per unit weight is very low and consequently large machines are necessary. Nevertheless, the dense air machine, as it is called, finds favor in many places such as on shipboard or in hotels.

To secure a large refrigerating effect per pound of refrigerant it is necessary to take advantage of one of the physical properties of a liquid and its vapor. When water is heated to the boiling point and then evaporated into steam a very large amount of heat must be put into it to effect the actual change from the liquid to the vapor state. It takes 180 thermal units to heat water from 32° to 212°, its boiling point under atmospheric pressure. After this boiling point is reached however, we must supply approximately 970 thermal units to convert each pound of the liquid into a pound of vapor, and in so doing we do not increase the temperature above 212° or the pressure above atmospheric. This "block" of heat which is required simply to change the physical state of the water into that of a vapor is known as the "latent heat of vaporization." If, during the removal of heat in the cooler of a refrigerating system, it is possible to make the refrigerant change from a vapor to a gas there will, because of the heat of vaporization, be a large amount of heat transmitted per pound of refrigerant.

It is possible to reduce the temperature at which water boils to 32° if the pressure on the surface of the water be reduced to .0886 pounds per sq. in. absolute. By so doing water vapor can be used as a refrigerant although, because of the necessity of producing a high vacuum in the system, it is not practical for temperatures much below 35° and is usually confined to the field between 35° and 50°.

Water, like air, is a safe medium. At the low pressure required, however, the vapor occupies very large volumes and the machinery is consequently of large size.

Air and water vapor, while being the safest refrigerants to use are not the most common principally because of the large size of the equipment that is required. Sulphur dioxide gas, carbon dioxide gas and ammonia gas are in more general use because, although they present certain difficulties, the size of the apparatus is not excessive.

As regards the latent heat of vaporization at a given temperature of these last mentioned mediums, ammonia gas has the largest value, and is followed in order by sulphur dioxide and carbon dioxide. In the volume requirements, however, carbon dioxide calls for the least, with ammonia gas second and sulphur dioxide third. The pressure demands present still a third order with carbon dioxide requiring rather high pressures, ammonia gas being midway, and sulphur dioxide gas lowest on the scale. All three gases are, of course, dangerous if allowed to escape in any quantity. In this regard, sulphur dioxide and ammonia give some degree of warning because of their odor whereas carbon dioxide does not.

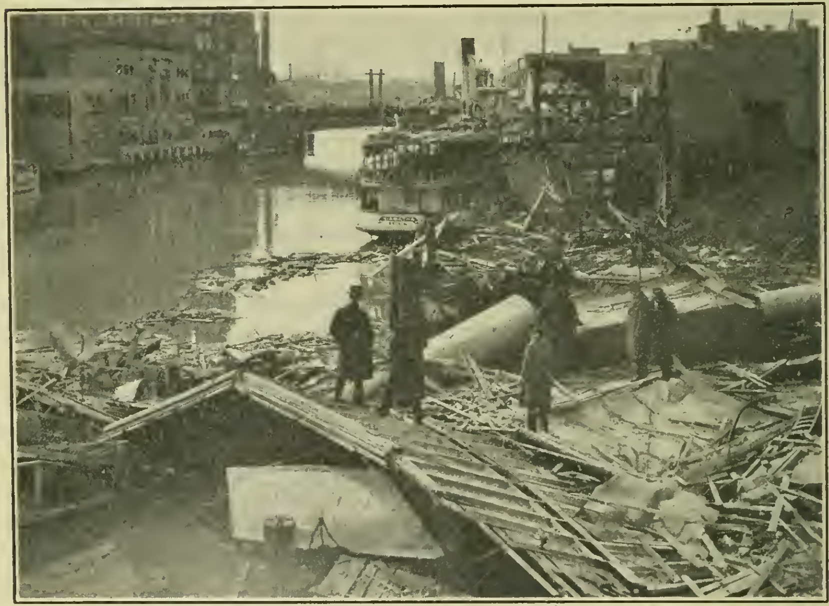
As regards the corrosive effect of the three gases it may be said that carbon dioxide has, under normal conditions, practically no effect. Sulphur dioxide in the presence of water may become corrosive at certain temperatures. Ammonia, however, is highly corrosive in action on brass or copper and consequently only iron or steel fitting can be used.

Carbon dioxide and sulphur dioxide are the *results* of combustion of carbon or sulphur with oxygen. They, therefore, will not burn. Ammonia gas, however, is inflammable under certain conditions as has been noted previously in The Locomotive.

The excessive pressure requirements of carbon dioxide gas have made it not so desirable as the other two for general use although it is well adapted to refrigeration requiring low temperatures. Comparing ammonia gas with sulphur dioxide gas, there are so many points in favor of the ammonia that it is not surprising that it has come into such general use as a refrigerant. Sulphur dioxide, on the other hand, while not possessing as much refrigerating value per pound, can be operated at moderate pressures and is favored for the smaller and portable machines such as the units now coming into use for domestic refrigerators.

Boiler Explosion on Steamer Omar D. Conger.

ATTENDING a funeral is not generally classed among hazardous occupations but a recent occurrence forcibly illustrated how near danger is even when least expected. A funeral service was being conducted in a chapel in Port Huron, Mich., when, without warning, a heavy steam heating radiator crashed into the midst of the two hundred people present and flying glass and timbers were thrown about the place. A woman was struck by a beam which fractured her collar bone and three ribs. Another woman lost an eye as the result of flying glass. Five others also were injured.



Boiler Explosion at Port Huron, Mich.

The flight of the radiator was one of several results caused by the explosion of a steam boiler on board the ferry steamer, Omar D. Conger, at Port Huron on Sunday afternoon, March 26, 1922. The scene of the accident, a general view of which is shown in the accompanying illustration, was on the Black River about 200 ft. east of Military Street bridge, Port Huron's principal street and in the center of the downtown section.

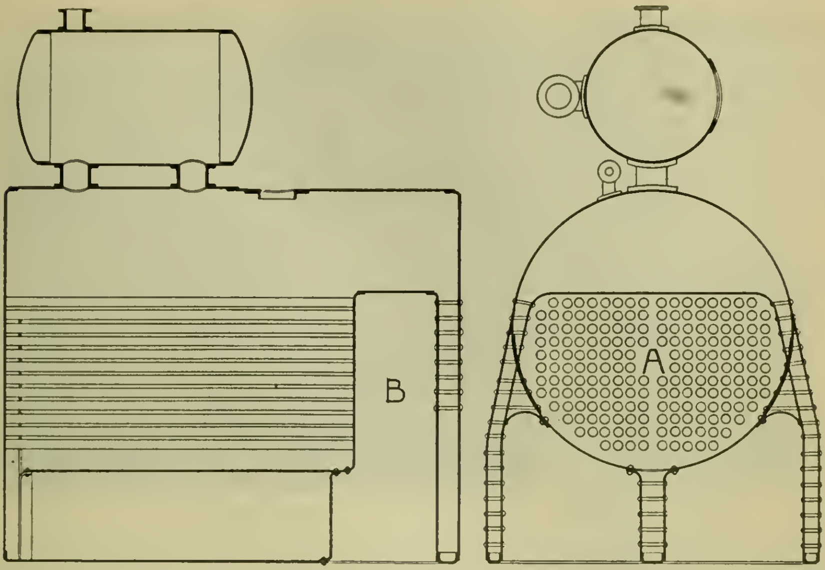


Fig. 2.

The explosion sent the hull of the steamer to the bottom of the river, which was not, however, deep enough to completely submerge it. Two other ferry steamers nearby were damaged and the force of the explosion was felt over a wide area, plate glass windows three blocks away being shattered by the blast.

The engineer, fireman and two deck hands were killed, seven persons were injured and the property loss which resulted was said to be in excess of $100,000.

The main portion of the boiler was thrown 250 ft. across a dock and over Quay Street, finally landing as illustrated in Fig. 3 on page 80, on a small frame house which was crushed like an eggshell by the impact. Fortunately, the occupants of the house were away at the time. Fire, following the landing of the boiler, completed the destruction of this house.

The Conger was owned by the Port Huron & Sarnia Ferry Co. It was built in 1882 and was rated at 196 gross tons, 92 feet long and 26 feet beam. The boiler which exploded was installed in 1904 so that it was eighteen years old.

The steamer had been in dry dock in February and was supposed to be in perfect condition. At the time the explosion occurred, it was tied up to a dock adjoining the ferry landing, taking on coal preparatory to making its first trip of the season. If the explosion had taken place a half hour later, after ferry passengers had gone on board, the loss of life would undoubtedly have been appalling.

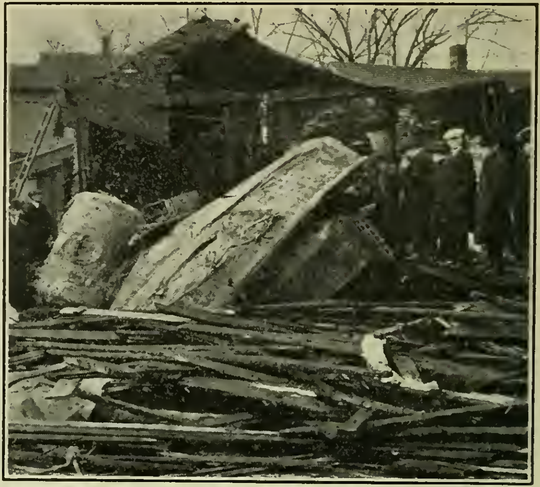


Fig. 3.

The boiler, a sketch of which is given in Fig. 2, was of the compact marine type made up of a cylindrical shaped upper section (A in Fig. 2) to which was riveted two outside and one middle water leg. The combustion space (B in Fig. 3) back of the grate was also enclosed at the rear by a water leg. The boiler was internally fired in two furnaces.

The force of the explosion ruptured the rear tube sheet, tore the rear water leg away from the side water legs and pulled away braces and staybolts at the rear end of the boiler.

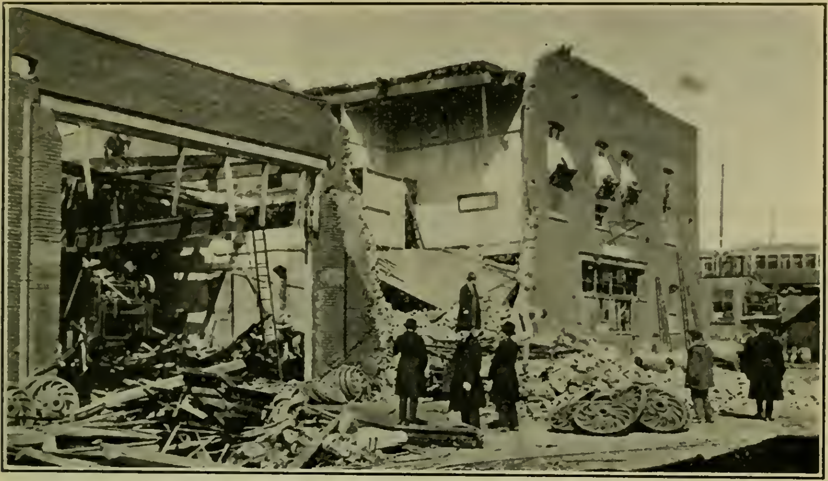
The steamer, which was valued at $75,000, was a total loss which unfortunately was not covered by insurance.

Air Receiver Explosions.

TO the casual observer air receivers or tanks are harmless looking objects. But a glance at the illustration on the opposite page, which shows the result of an air tank explosion, will give further evidence of the truth in the saying, " Appearances are sometimes deceiving."

This accident occurred in the machine shop of the Kansas City Railways Co., Kansas City, Mo., early in the morning of March 7th, 1922. Five men were killed outright, two died later from injuries they received and ten persons were more or less seriously injured. The property loss was said to be in excess of $25,000.00.

The receiver which exploded was equipped with a safety valve and on the compressor there was an unloading device which was set to operate at 104 lbs. gauge pressure. Furthermore, an attendant was



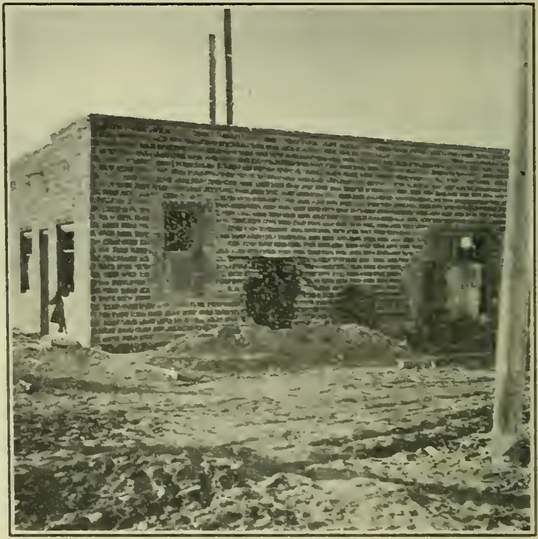
Air Tank Explosion at Kansas City, Mo.

detailed to care for the compressor and to guard against overpressure. Notwithstanding these precautions, however, the receiver exploded with extreme violence and no definite conclusions have, as yet, been reached as to the cause.

There is a well accepted theory that air receivers are subject to the hazard of an explosion resulting from ignition of combustible matter which is carried into the tank with the air from the compressor, and which may be drawn in from the outside air or may result from the oil used in lubricating the compressor cylinder. If such matter were present in a vessel filled with air at a high pressure, and if it were ignited, a combustion explosion would be the result and considerable damage would be done. It has not been clearly demonstrated as to what the source of such an ignition might be although, in a number of cases, including the Kansas City Railway accident, a flash of fire has been seen so that the theory has been well supported. Such accidents are difficult to guard against.

Air receiver explosions have been numerous, particularly within the past year. In July, 1921, there was an accident of this kind at San Francisco, Cal., a full account of it being given in the California Safety News for September, 1921. Fortunately, but little property damage was done and there were no personal injuries. This may be accounted for by the fact that both heads of the receiver, which, by the way, was an old boiler drum, let go at the same time so that the energy was rapidly dissipated in both directions.

On the 12th of December, 1921, an air receiver exploded at the Winnett Electric Light & Power Co., Winnett, Montana. One man was killed and one was injured. The tank, a secondhand one, which was 22 inches in diameter and 5 feet long, had been installed less than two months before the date of the accident. The longitudinal seam was autogenously welded and the heads were brazed in, failure taking place along these welded and brazed joints. When the explosion took place the tank was blown through the brick wall of the plant as shown in the illustration. The flattened wrapper sheet of the tank with the two heads may be seen in line with the door a little to the right of the center of the picture.



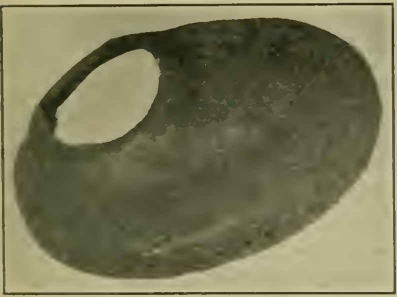
Explosion at Winnett, Mont.

There was undoubtedly a combustion explosion in connection with this accident, for a witness stated that a flash of fire was seen at the time of the accident.

The next air receiver explosion of which there is a record is one which occurred at Miami, Florida, on December 28th, 1921. The receiver, the heads of which had been welded in, was used in connection with a gasoline engine driven compressor and failure was due to the weakness of the welds. The compressor was in use on the construction of the First National Bank at Miami and, whereas no personal injuries were sustained, the engine and the compressor were badly damaged and work on the building was delayed for a great length of time until repairs could be made.

Soon after the last mentioned accident, another occurred in a garage at Greensboro, North Carolina. The receiver, in this case, was used for the storage of air at 200 lbs. pressure, the safety valve being set to blow at 250 lbs. The heads were said to be connected to the shell with a brazed joint and when leakage occurred at one of these joints someone rather foolishly attempted to close this leak with a caulking tool. After two or three blows of the hammer, the head of the tank blew out. The man who was attempting the repairs was killed and his helper was badly injured.

On February 24th of the present year the head on an air tank belonging to The France Co. of Huntington, Ind., ruptured and the manhole cover was driven through two floors and a side wall of the building. There is some mystery about the accident since it was stated that the safety valve on the tank had been blowing freely for some time when the hand on the pressure gauge was suddenly seen to swing around as far as it could go. Before the pressure could be reduced the tank failed.



Head of Air Tank at Huntington, Ind.

At the plant of the Denver Auto Laundry Company, Denver, Colorado, an autogenously welded air receiver exploded, on March 27th, causing considerable damage. The tank had been installed only the day before the accident. A short time after the air compressor had been started and when the pressure in the tank had reached a pressure of about 75 lbs. the top head of the tank, which was placed in a vertical position, blew out and went through the roof of the building, landing about two blocks away in the rear of an hotel. Boards and bricks were hurled for a block or more, coming to rest on the sidewalk and street. Considering the locality where the accident occurred — a short distance from the Court House and where the sidewalks are usually crowded — it is remarkable that no one was injured.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION
PUBLISHED QUARTERLY

WM. D. HALSEY, EDITOR.

HARTFORD, JULY, 1922.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

IF the coal we buy does not burn easily in our boiler furnaces, we find ourselves in great trouble and often, at much expense, we redesign our furnace equipment to get better combustion. Coal — many tons of it — can be lost, however, in the storage piles before it ever reaches the fire door.

Bituminous coal is subject, under certain conditions, to spontaneous combustion so that fires may break out within a pile of such fuel and do serious damage if not promptly attended to. In times past this trouble was not commonly experienced because it was not the practice for the average industrial plant to carry large reserves of coal. The coal pile could easily be replenished when it became small and storage of large quantities was not necessary. Present day conditions, however, require that a generous reserve supply be carried at all times if continuous operation is to be assured. The larger the storage pile the more accentuated is the danger of spontaneous combustion and the more disastrous are the results of a fire.

Industrial plants will probably, within a short time, be replenishing their coal reserves and at such a time provision can be made for storing the coal by methods that have been found to give the greatest degree of safety from fire. In this regard we desire to call particular attention to the article under the title of "Saving the Coal Pile" in this issue of THE LOCOMOTIVE. The causes of spontaneous combustion, the methods of detecting and extinguishing fires, and the ways of storing coal will, we believe, be of interest to our readers and of value to them in protecting their fuel reserves against serious loss.

IGNITION TEMPERATURE OF FUELS.

Under ordinary conditions the ignition temperature of a fuel is less important than the maintenance of combustion. No matter how large the mass of fuel may be, whether it is in a blast furnace, under a boiler, or in an ordinary household furnace, the origin of the heat necessary to raise this fuel to the ignition temperature is in the kindling which starts the fire. Hence the starting of an ordinary fire is a process depending upon the application of an outside source of heat, always at a high temperature, to some portion of the mass of coal until a part of the coal itself burns and propagates heat to the remainder.

It is, however, in connection with the storing of coal in piles that the ignition temperature takes on a real significance. Coal is actually burning at all times and even at low temperatures. If the heat thus produced is sufficiently confined and air is supplied to the coal at the proper rate the temperature of the interior of the mass will rise. As the temperature rises the rate of combustion also rises and after a certain safe temperature is passed the process goes on quite rapidly until burning or flame results. Bulletin No. 128 of the Engineering Experiment Station of the University of Illinois, "The Ignition Temperature of Coal" by R. W. Arms makes a study of this problem with the object of determining the influence of the temperature of ignition of the various coals upon the liability to fire while in storage. In this bulletin is given a discussion of what point may actually be designated as the ignition temperature and what factors influence that point, the methods for determining the ignition temperature of different coals, and the results of tests upon the various coals used in this investigation.

Copies of Bulletin No. 128 may be had without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

Personal.

Mr. A. Paul Graham was appointed, on May 1st of this year, manager of the Cleveland Department of the Company to succeed the late Mr. H. A. Baumhart.

Mr. Graham has been connected with the New York Department of the Company for the past twelve years as an underwriter and special agent, and we feel that he is particularly well adapted to succeed Mr. Baumhart.

Accidents Cripple 159,000 Horsepower of Ontario Hydro Units.

A SERIOUS accident involving a loss of several million dollars occurred in the generating station of the Ontario Power Company at Niagara Falls, Ontario, shortly before three o'clock on the morning of April 20th. Generating units No. 15 and 16 rated at 20,000 horsepower each were destroyed and when a part of the generator of unit No. 15 was hurled through the roof the entire covering of the new wing fell, smashing the casings of two turbines as well. The Johnston valves controlling the flow of water to the turbines were shut as soon as possible, but during the interim the water shot over the roof, flooded the whole bay, washed out part of the embankment to the rear and rushed into the main power house, flooding units No. 11, 12, 13 and 14, rated at 16,000 horsepower each. One operator was in the damaged wing at the time and saved his life by swimming. His escape from the wreck however, was nothing short of miraculous. Fortunately the stop locks at the end of the station were out at the time, or the whole power house would have been flooded.

An official investigation is being conducted into the cause of the accident, the result of which will be published later. As far as can be learned the contributory cause of the mishap was a short circuit somewhere on the line of the Hydro Electric Power Commission about 2:45 on the morning of April 20th. The sudden dropping of the load caused the units feeding the line to speed up. At that time four units in the power house of the Canadian Niagara Falls Power Company, rated at 10,000 horsepower each, were running in parallel with the units in the Ontario Power Company's station. When the operator in the Canadian Niagara station saw the four units speeding he pulled over the rheostats as far as they would go, and also threw in the relays on the generators, in an effort to cut down the voltage. This however had no effect, and when it was discovered that the units were being driven as motors by the larger generators in the Ontario Power Company's station, the feeder switches were pulled and the Canadian Niagara Units cut off the line. Shortly afterwards unit No. 15 in the Ontario Power Company's station flew to pieces.

The destroyed wing of the power house, with its equipment, was erected by the Hydro Electric Power Commission of Ontario during the war, to meet the great demand for power at that time. This increased the total capacity of the station of the Ontario Power Company from 160,000 horsepower to 200,000 horsepower, and necessitated the installation of a woodstave pipe line with an internal diameter of 13½ ft. and the two 20,000 horsepower units. The temporary end wall of the old Ontario Power Company's station separated the main station from the new wing. These additions to the power house cost approximately $3,500,000.

The water wheels were not specially designed for the installation, but were obtained from the Aluminum Company's plant at Baden, North Carolina. They were built by S. Morgan Smith and delivered 14,000 horsepower at Baden, but under the head obtaining at Niagara Falls developed 20,000 horsepower. The generators were built by the Canadian General Electric Company. A section of unit No. 15 weighing many tons, which went through the roof, dropped back through the station, about 150 ft. distance, and cut out a piece of the base of unit No. 11. The force with which the piece descended was such as to make a cut almost as clean as if it were made by a machine tool, but the base of the machine was not cracked or otherwise damaged. Some doubt has been expressed whether units No. 15 and 16 will be replaced, inasmuch as the Commission is under obligations to remove the temporary wooden stave pipe line by 1923, and can use the water to better advantage in the new Queenston station. The other four units are still being dried out.

A few days prior to the accident one of the large units in the Chippewa-Queenston station rated at 55,000 horsepower was damaged. Fins of the fans attached to the generator for ventilating purposes dropped off and became wedged between the motor and the winding, injuring about 15 coils. This necessitated shutting down the machine, and rewinding it, an operation which will require about three weeks. Meanwhile a third 55,000 horsepower unit is being erected at Queenston, and it is hoped to have this third machine in operation by July.

The power houses of the Toronto Power Company and the Canadian Niagara Falls Power Company are being operated with their gates wide open, so as to supply the Hydro Electric Power Commission of Ontario with the requisite energy. Part of the loss is also being made up from the Niagara Falls Power Company's American Plant. Less than fifteen minutes after the accident the Canadian Niagara Falls Power Company and the Toronto Power Company were feeding the Hydro Electric Power System, which within a week lost two 20,000 horsepower units and the use of four 16,000 horsepower and one 55,000 horsepower units.—*From Electrical World.*

Caught in the Separator.

BULLETS SAVE THE DAY AS POWER PLANT STACK BUCKLES.

Marcellus, Mich.— Local sportsmen came to the village's relief after the smokestack on the local electric lighting plant had buckled, fallen over, and cut off the draft in the boilers, leaving the community in darkness.

There was no ladder in the village long enough to enable workmen to make the repairs, but marksmen armed with every known kind of "shooting iron," fired volley after volley into the stack until bullets severed the pipe and removed the cause of the trouble.

From the middle of the forenoon until afternoon, the stack was bombarded and the sound of the firing was heard for several miles.

Officials at the lighting plant estimated it would have taken a week to make the repairs but for the happy thought of a member of the rifle club.— *The Free Press.*

The local draft boards should be revived for cases like this.

MUSIC TRAVELS FROM AIR INTO BOILER AT MILL.

Greenville, Ala.— While the boiler in the plant of the W. T. Smith Lumber Company of Chapman, near here, was being cleaned, E. Cooper and Bert Harrison, with a negro named Soap Monroe, who were inside the boiler heard a band playing. The notes were distinct and audible, coming down the metal smokestack.

It is supposed that the metal smokestack acted as a receiver, the guy wires being the antennae and a wireless radio concert which was being sent out was received. No music was being played in that vicinity.

The negro being of a superstitious character made a hasty getaway.

Some popular song writer will see this and then the next piece of jazz music to appear will be "The Boiler Room Blues."

DYED-IN-THE WOOL P. A.

"Yes," said the specialist, as he stood at the bedside of the sick purchasing agent, "I can cure you."

"What will it cost?" asked the sick man, faintly.

"Ninety-five dollars," answered the specialist.

"You'll have to shade your price a little," replied the P. A. "I have a better bid from the undertaker."— *The Pay-Bill.*

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JUNE, 1921 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
259	18	Failure of crown sheet on locomotive			Texas-Mexican Railway Co.	Railroad	Laredo, Texas
260	18	Tube ruptured			Scullin Steel Co.	Steel Mill	St. Louis, Mo.
261	19	Boiler exploded			Geneva Foundry Co.	Foundry	Geneva, N. Y.
262	20	Header cracked		1	Pittsburgh Plate Glass Co.	Glass Mfgrs.	Ford City, Pa.
263	20	Rupture of blow off valve		1	Luwig Kinkhorst Ice Plant		Brunswick, Mo.
264	20	Tube ruptured			Columbus-Union Oilcloth Co.	Oilcloth	Columbus, Ohio
265	21	Boiler bagged and ruptured			Early & Daniel Co.	Grain & Hay	Cincinnati, Ohio
266	21	Boiler bulged and ruptured			Wisconsin Sugar Co.	Sugar Factory	Menominee F., Wis.
267	21	Five sections heating boiler cracked			Peoples Institute of Northampton	Institute	Northampton, Mo.
268	22	Section heating boiler cracked			A. F. Clark	Apt. House	Cambridge, Mass.
269	24	Section of heating boiler cracked			Westminster School	School	Simsbury, Conn.
270	29	Section of heating boiler cracked			Holyoke Supply Co.	Steam Supplies	Holyoke, Mass.

MONTH OF JULY, 1921.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
271	1	Section of heating boiler cracked			A. C. Johnson	Apt. House	Denver, Colo.
272	1	Blow off pipe failure			O. L. Thompson	Saw Mill	Burgaw, N. C.
273	2	Header cracked			Cliff Ice & Cold Storage Co.	Ice & Cold Storage	Dallas, Tex.
274	3	Domestic water boiler exploded			Williston Walker	Residence	Brattleboro, Vt.
275	8	4" cast iron fitting burst			American Linen Co.	Cotton Mill	Fall River, Mass.
276	8	Tube ruptured		1	N. G. Butch, Dr. Beef Co.	Butchers	New York, N. Y.
277	8	Boiler of locomotive exploded		1	Galveston, Harrisburg and Antonio R. R.	Railroad	Alpine, Texas
278	8	Flue ruptured				Railroad	Savanna, Ill.
279	9	Boiler bulged and ruptured			Consumers Ice Co.	Ice & Cold Storage	Ft. Wayne, Ind.
280	10	Tube ruptured			Meek Ice Co.	Ice & Cold Storage	Greensburg, Ind.

MONTH OF JULY, 1921 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
281	11	Mud drum burst	1		Public Service Corp. of N. Y.	Power Station	Newark, N. J.
282	12	Tube ruptured	1		Westmoreland Coal Co.	Coal Mining	Biddle, Pa.
283	14	Boiler exploded	1		Lute Campbell	Threshing Mch.	Kingman, Mo.
284	14	Boiler exploded	1		Chas. Truesdell	Saw Mill	Williamstown, N. Y.
285	15	Boiler exploded			Meeker Bros.	Threshing Mch.	Warsaw, Mo.
286	15	Crown sheet pulled from stays			Weis-Patterson Lumber Co.	Lumber	Pensacola, Fla.
287	15	Accident to feed pipe			Cobbs & Mitchell	Lumber Mill	Cadillac, Mich.
288	15	Section of heating boiler cracked			John R. Thompson	Restaurant	Philadelphia, Pa.
289	16	Vulcanizer exploded		3	B. F. Goodrich Co.	Rubber Works	Akron, Ohio
290	16	Heating boiler exploded			Y. W. C. A.	Y. W. C. A.	Fresno, Cal.
291	18	Furnace collapsed			Swift & Co.	Meat Packers	Lincoln, Nebr.
292	18	Boiler exploded	1	4	Federal Prison	Prison	Leavenworth, Kan.
293	18	Boiler exploded	1	1	Herman Berndt	Threshing Mch.	Markesan, Wis.
294	19	Flue ruptured		2	Erie R. R.	Railroad	Port Jarvis, N. Y.
295	19	Tube sheet pulled from stays			Wilts Veneer Co.	Veneer	Plymouth, N. C.
296	19	Header cracked			Pittsburg Plate Glass Co.	Glass	Crystal City, Mo.
297	20	Ammonia pipe burst		4	South Hills Ice Co.	Ice Plant	South Hills, Pa.
298	21	Tube pulled through tube sheet			Phila. Rubber Works Co.	Rubber Works	Akron, Ohio
299	22	Boiler exploded	1	3	Davis-Falconer	Threshing Mch.	Longford, Kan.
300	22	Steam pipe burst	1		Steamer Admiral Farragut	Steamship	San Francisco, Cal.
301	22	Domestic water heater exploded			W. A. Pierson	Residence	Oakland, Cal.
302	22	Section heating boiler cracked			First Ecc. Church	Church	Winsted, Conn.
303	22	Boiler bulged and ruptured			Edmond Ice Co.	Ice Plant	Edmond, Okla.
304	25	Furnace sheet bagged & ruptured			City of Providence	Lighting Plant	Providence, Ky.
305	26	Boiler exploded	1		Cresceus Oil	Drilling for Oil	Taft, Cal.
306	26	Steam pipe burst			Santa Fe Building	Office Bldg.	San Francisco, Cal.
307	27	Boiler exploded	3	4		Threshing Mch.	Montgomery, Mo.
308	27	Boiler exploded	3	4		Threshing Mch.	Wellsville, Mo.
309	28	Tube ruptured			Woodward Iron Co.	Pig Iron	Woodward, Ala.
310	28	Blow off pipe failure			Steinle & Steinle	Cotton Gin	Jourdanton, Tex.
311	28	Crown sheet collapsed		2	Horse Shoe Lumber Co.	Lumber Mill	River Falls, Ala.
312	29	Tube ruptured			Michigan Alkali Co.	Chemicals	Wyandotte, Mich.

313	29	Failure of blow off pipe			Nuway Laundry Co.	Laundry	Oklahoma City, Okla.
314	30	Header broke			Westinghouse Air Brake Co.	Air Brake Mfgrs.	Wilmerding, Pa.
315	30	Fire sheet ruptured			T. J. Pace	Ice & Cold Storage	Sabetha, Kan.

MONTH OF AUGUST, 1921.

316	1	Boiler header broke			Westinghouse Air Brake Co.	Air Brake Mfgrs.	Wilmerding, Pa.
317	2	Angle steam valve burst	2		Lackawanna & Wyoming Val. Co.	Power House	Scranton, Pa.
318	2	Tractor boiler exploded	3	1	A. J. Rockwood	Contractor	Genoa, N. Y.
319	2	Thresher boiler exploded		3	John Tuohy	Farm	Elmira, Minn.
320	3	Clothes pressing machine exploded		3	Luigi La Rocco	Garment Factory	Philadelphia, Pa.
321	4	Boiler blow-off pipe ruptured		1	Mason Coal Co.	Power Plant	Hartford, Conn.
322	6	Tractor boiler exploded			Simon Farrel	Farm	Plainfield, Ill.
323	6	Crown sheet of locomotive boiler collapsed		4	Wilt's Veneer Co.	Veneer Mill	Ayden, N. C.
324	6	Boilers exploded	40	31	Steamship Alaska	Steamship	Blunt's Reef, Cal.
325	8	Boiler exploded	2	7	Finney Arthur Lumber Co.	Planing Mill	Lacy, Fla.
326	9	Traction boiler exploded		1	James Cox	Traction Engine	Hindsboro, Ia.
327	9	Air tank exploded			Union Ice Plant	Ice Factory	Oakland, Cal.
328	12	Tube ruptured		1	St. Petersburg Lighting Co.	Power Plant	St. Petersb'g, Fla.
329	12	Boiler bulged and ruptured			Pardeeville Canning Co.	Canning Factory	Pardeeville, Wis.
330	12	Laundry mangle exploded. See Locomotive October, 1921		10	Hotel Pemberton	Hotel	Hull, Mass.
331	13	Blow-off pipe failed			Norfolk Light & Fuel Co.	Gas Plant	Norfolk, Neb.
332	14	Launch boiler exploded		1	Launch "Bertha B."		Philadelphia, Pa.
333	15	Section of boiler cracked			Hirsh Bros.	Bakers Supplies	Chicago, Ill.
334	15	Sections of heating boiler cracked			Bd. of Education, Henderson, Ky.	School	Henderson, Ky.
335	15	Headers ruptured			Salmen Brick & Lumber Co.	Saw Mill	Slidell, La.
336	15	Cracked sheets			Memphis Packing Corp.	Packing Plant	Memphis, Tenn.
337	15	Boiler exploded		3	E. P. Coughlin Co.	Asphalt Mfgrs.	Milwaukee, Wis.
338	16	Boiler exploded			Burk Farm	Saw Mill	Butler, Pa.
339	17	Boiler steam pipe ruptured			The Winchester Rptg. Arms Co.	Ammunition Mkrs.	New Haven, Conn.
340	18	Tube sheet cracked			Nichols Copper Co.	Copper Refining	Laurel Hill, L. I.
341	21	Heating boiler exploded		1	John F. Pendergast	Dwelling	Dorchester, Mass.
342	22	Three boilers exploded	5	3	West Va. Pulp & Paper Co.	Paper Mill	Mechan'ville, N. Y.
343	25	Tube ruptured			F. A. Poth & Sons, Inc.	Brewery	Philadelphia, Pa.
344	25	Boiler exploded		1		Oil Well	Beattie, Kan.
345	27	Boiler exploded		1	Midway Success Oil Co.	Oil Well	Taft, Cal.

MONTH OF AUGUST, 1921 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
346	27	Tube ruptured			City of Pittsburgh	Water Pumpg. Plt.	Pittsburgh, Pa.
347	27	Blow-off pipe failed			Farmers Gin Ass'n	Cotton Gin	Normanna, Tex.
348	28	Blow-off valve fractured			Horlicks Malted Milk Co.	Malted Milk	Racine, Wis.
349	29	Main stop valve burst		1	Frick Company	Machine Shop	Waynesboro, Pa.
350	30	Tube ruptured			City of Pittsburgh, Pa.	Water Pumpg. St.	Pittsburgh, Pa.
351	31	Air tank exploded			Sutter Garage	Auto Garage	Yuba City, Cal.

MONTH OF SEPTEMBER, 1921.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
352	1	Tube ruptured			American Gas & Electric Co.	Power House	Windsor, West Va.
353	1	Cracked header			Pittsburgh Plate Glass Co.	Plate Glass Mfgrs.	Crystal City, Mo.
354	1	Boiler bagged and ruptured			Otto Muelder	Cotton Gin	New Berlin, Tex.
355	1	Boiler exploded		1	C. A. Harry	Oil Well	Towanda, Kan.
356	2	Tubes ruptured			Service Ice Co.	Ice Plant	Indianapolis, Ind.
357	2	Header cracked			The Barrett Co.	Tar Extraction	E. Toledo, Ohio
358	3	Heating boiler exploded		15	Yale Hotel	Hotel	Long Beach, Cal.
359	3	Boiler exploded			Darling & Co.	Fertilizer Plant	Chicago, Ill.
360	5	Boiler fire sheet bagged and ruptured			Carty-Dever Co., Inc.	Packing House	Rockford, Ill.
361	6	Tube ruptured in locomotive		3	Erie R. R.	Railroad	Red House, N. Y.
362	6	Bleaching tank exploded			Yates Bleachery	Bleachery	Flintstone, Ga.
363	7	Tube ruptured			Ice Service Co.	Ice Plant	Richm'd, Hill, L. I.
364	8	Sheets bagged and ruptured			New Samaritan Hospital	Hospital	Sioux City, Ia.
365	8	Cracked header			Pittsburgh Plate Glass Co.	Plate Glass Mfgrs.	Creighton, Pa.
366	8	Head pulled away from tubes			T. B. Cook	Cotton Gin	Canton, Miss.
367	11	Steam pipe ruptured		3	Steamship "Brush"	Steamship	San Fran'co, Cal.
368	11	Boiler exploded			J. W. Archer & Son	Canning Factory	Wilna, Del.
369	12	Steam pipe burst			Lisbon Mills	Cotton Mills	Lisbon, Me.
370	13	Blow-off pipe failed			Franklin Ice & Cold Storage Co.	Ice Plant	Franklin, Tenn.
371	14	Section of heating boiler cracked			S. & H. A. Blumenthal, Inc.	Apartment House	New York City
372	15	Section of heating boiler cracked			Board of Education	School	Fort Recovery, O.
373	15	Feed water pipe burst			Elkhart Gin Co.	Cotton Gin	Elkhart, Tex.
374	15	Boiler exploded	2			Saw Mill	Venus, Fla.

375	16	Blow-off pipe threads stripped		1	E. K. Reddell	Cotton Gin	Iberis, Tex.
376	18	Tube ruptured			United Gas Improvement Co.	Gas Plant	Syracuse, N. Y.
377	19	Locomotive boiler exploded		2		Locomotive	Ford, Cal.
378	20	Boiler exploded	1	2	McCown-Clark Co.	Cotton Gin	Florence, S. C.
379	21	Boiler exploded	1	6	Yacht "ˆambria"	Steamship	Lake Michigan
380	21	Boiler exploded	1			Cotton Gin	Womble, Ark.
381	23	Rendering tank ruptured			Kauf & Rinderspacher Co.	Slaughter House	Hastings, Nebr.
382	23	Thresher boiler exploded	4	2	Sidney R. Ward	Grain Threshing	Bonetrail, N. D.
383	23	Boiler bagged and ruptured			Naive-Spiller Corp.	Refrigerating Pl't	Nashville, Tenn.
384	24	Tube ruptured		1	Ice Service Co., Inc.	Ice Plant	Richm'd Hill, L. I.
385	25	Section of heating boiler cracked			Grace L. Smith	Apartment House	San Fran'co, Cal.
386	28	Boiler exploded	1		Windsor House	Hotel	Ashton, S. D.
387	29	Steam dome of boiler cracked			Worm & Company	Packing House	Indianapolis, Ind.
388	30	Section of C. I. heating boiler cracked			State Bank of E. Moline, Ill.	Bank	E. Moline, Ill.
389	30	Circulating pipe burst			Proctor & Gamble	Fibre Plant	Jackson, Miss.
390	30	Section of heating boiler cracked			R. C. Taylor Est.	Residence	Worcester, Mass.
391	30	Heater manifold cracked			State Normal School, Athens, Ga.	School	Athens, Ga.

MONTH OF OCTOBER, 1921.

392	1	Tube ruptured			Water, Light & Transit Co.	Power Plant	Carrolton, Mo.
393	1	Header cracked			Pittsburg Plate Glass Co.	Glass Works	Creighton, Pa.
394	1	Section of heating boiler cracked			General Motors Corp.	Auto Mfgrs.	Baltimore, Md.
395	1	Steam pipe burst		1	City Water Works	Pumping Plant	Huron, S. D.
396	3	Water heater exploded		1	Thos. W. O'Brien	Residence	Brooklyn, N. Y.
397	3	Section of heating boiler cracked			John R. Thompson Co.	Restaurant	Memphis, Tenn.
398	3	Heating boiler exploded			Norwich Hospital	Hospital	Norwich, N. Y.
399	4	Fitting on of the heating line failed			Sayles Finishing Plants	Textile Plant	Saylesville, R. I.
400	5	Section of heating boiler cracked			Anderson School Board	School	Anderson, S. C.
401	5	Sections of heating boiler cracked			Stanley Co. of America	Theater	Philadelphia, Pa.
402	5	Section of heating boiler cracked			Gregory Bros.	Hotel	Connellsville, Pa.
403	6	Section of heating boiler cracked			Town of Wayland	School	Wayland, Mass.
404	7	Tube ruptured			Lunkenheimer Co.	Brass Plant	Cincinnati, Ohio
405	7	Sections of heating boiler cracked			Lancaster Leather Co.	Leather-board Mill	Lancaster, Ohio
406	7	Section of heating boiler cracked			Armsmith Realty Co.	Apartment House	New York City.
407	8	Crown sheet failed			Solvay Process Co.	Coke Plant	Ashland, Ky.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1922

Capital Stock, . . $2,000,000.00

ASSETS

Cash in offices and banks	$492,329.45
Real Estate	150,000.00
Mortgage and collateral loans	1,673,850.00
Bonds and stocks	6,429,307.52
Premiums in course of collection	766,619.61
Interest Accrued	120,981.61
Total assets	$9,633,088.19

LIABILITIES

Reserve for unearned premiums		$4,602,639.11
Reserve for losses		213,814.87
Reserve for taxes and other contingencies		396,621.24
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,420,012.97	
Surplus to Policy-holders		**$4,420,012.97**
Total liabilities		$9,633,088.19

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President and General Counsel.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.

BOARD OF DIRECTORS

ATWOOD COLLINS, President, Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Bank, Hartford, Conn.
MORGAN B. BRAINARD, Vice-Pres. and Treasurer, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
FRANCIS T. MAXWELL, President, The Hockanum Mills Company, Rockville, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Ass't Treas., Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Company.
SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.

Incorporated 1866. THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLYWHEEL EXPLOSIONS AND ENGINE BREAKAGE

Department	Representatives
ATLANTA, Ga.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abell Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	Charles D. Noyes, Chief Inspector.
BRIDGEPORT, Ct.,	W. G. Lineburgh & Son, General Agents.
405 City Savings Bank Bldg.	E. Mason Parry, Chief Inspector.
CHICAGO, Ill.,	J. F. Criswell, Manager.
209 West Jackson B'l'v'd	P. M. Murray, Ass't Manager.
	J. P. Morrison, Chief Inspector,
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio,	W. E. Gleason, Manager.
First National Bank Bldg.	Walter Gerner, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chesnutt,
016-918 Gas & Electric Bldg.	Manager and Chief Inspector.
HARTFORD, Conn.,	F. H. Kenyon, General Agent.
56 Prospect St.	E. Mason Parry, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector.
Hibernia Bank Bldg.	E. Unsworth, Ass's Chief Inspector.
NEW YORK, N. Y.,	C. C. Gardiner, Manager.
100 William St.	Joseph H. McNeill, Chief Inspector.
	A. E. Bonnett, Ass't Chief Inspector,
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	Wm. J. Farran, Consulting Engineer.
	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	McCargar, Bates & Lively, Gen'l Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
540 New York Block	H. R. Mann, & Co., General Agents.
SAN FRANCISCO, Cal.,	J. B. Warner, Chief Inspector.
339-341 Sansome St.	C. D. Ashcroft, Manager.
ST. LOUIS, Mo.,	Eugene Webb, Chief Inspector.
319 North Fourth St.	H. N. Roberts, President. The Boiler Inspection and Insurance Company of Canada.
TORONTO, Canada,	
Continental Life Bldg.	

My Country

YOUR country is all that surrounds you, all that has reared and nourished you, everything that you have loved. That land you see, those houses, those trees, those smiling girls that pass, that is your country. The laws that protect you, the bread which rewards your toil, the words you exchange, the joy and the sadness which come to you from men and the things amid which you live, that is your country! The little chamber where you once saw your mother, the recollections she has left you, the earth where she reposes, that is your country. You see it, and you breathe it everywhere! Imagine, my son, your rights and your duties, your affections and your needs, your recollections and your gratitude, all united under one name, and that name will be

"MY COUNTRY"

EMIL SOUVESTRE
French Author, Soldier, and Patriot
—"Scope."

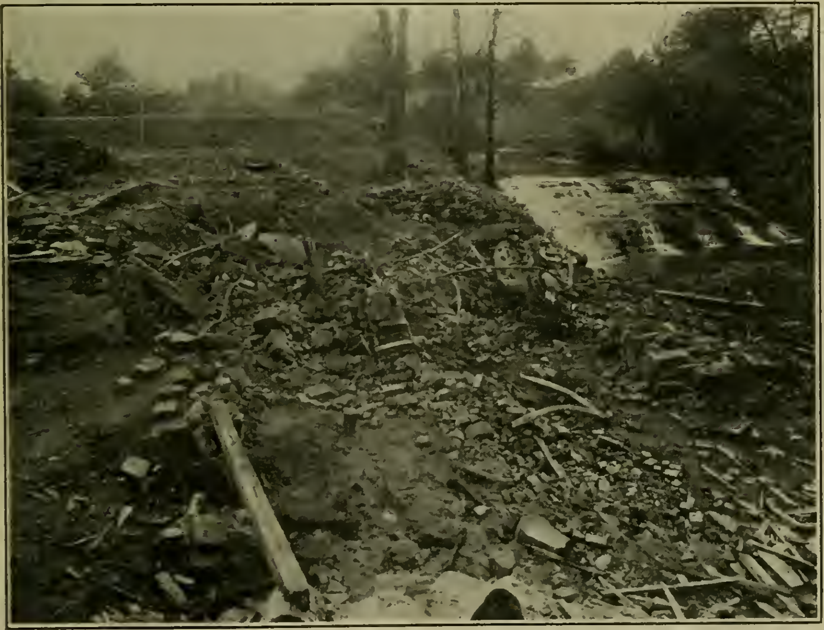
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIV. HARTFORD, CONN., OCTOBER, 1922. No. 4

COPYRIGHT, 1922, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



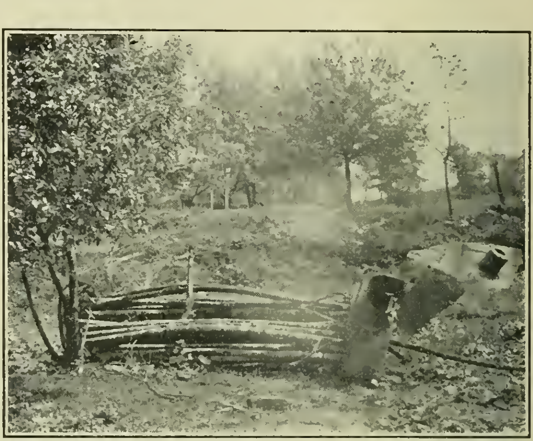
BOILER EXPLOSION IN A SAW MILL AT LEROY, OHIO.

THERE IS VALUABLE INFORMATION FOR YOUR ENGINEER IN THIS MAGAZINE. PLEASE LET HIM SEE IT.

A Saw Mill Boiler Explosion.

THE picture on the front page of this issue is not the effect of shell fire on the battle fields of Flanders, but is the result of the explosion of a saw mill boiler in Ohio.

It did a very thorough job as far as destroying this mill is concerned and the boiler landed, as shown in the cut on this page, about 200 feet away, wrecking the roof of a barn in its flight.



Landing Place of Boiler.

The boiler was located before the explosion in a saw mill two and one-half stories high and was of the horizontal tubular type about 30 years old and operated at 80 lbs. (?) pressure. Up to two years ago the boiler was operated at 100 lbs. pressure, but at the time of the investigation following the accident, the operator stated that two years ago he decided that he had better cut the pressure down, so he "went up on the top of the boiler and screwed the pop *down* (which would of course raise instead of lower the blowing pressure), and was pretty sure that it blew at 80 lbs." The safety valve could not be found after the explosion. The boiler had not been inspected within the two years previous to the explosion, nor had the steam gauge been tested within that time.

Upon examining the internal surface of what was left of the boiler it was found that the shell plate and tubes were very badly pitted and grooved. The break on the plate edges was abrupt with no knife edge anywhere. The shell plates tore completely away from the head and tubes, at a point about three inches from the joint and no rivets were sheared. The owner had just finished sawing a log and was loading the carriage preparatory to sawing another log, when the boiler let go, the building collapsed and a beam fell across either the engine or the saw carriage in such a way as to form a pocket and protect him from the falling beams.

The boiler was not insured, and the disaster is only one more illustration of the danger of operating boilers without adequate inspection and insurance.

Fatigue of Metals.

A ONE inch square bar of steel placed vertically with its upper end fixed might support at its lower end a load of 60,000 pounds for all time to come if that load were not changed in any way. However, if a load of but 30,000 pounds were alternately applied and removed from the bar it would very likely break when the action had been repeated a certain number of times. This phenomenon of a material breaking under a repeated load which is less in value than that sufficient to cause failure if constantly applied is known as "fatigue failure" and has been the subject for investigations by many scientists for approximately three-quarters of a century.

The latest of these investigations and a series which is perhaps one of the most important thus far conducted is that which recently was carried out at the University of Illinois, Urbana, Ill. The general policies for this investigation were formulated by an Advisory Committee of the Engineering Division of the National Research Council. Expenses were met by a fund subscribed by the Engineering Foundation and the General Electric Company, while the University of Illinois provided a laboratory, the time of one of the professors and considerable apparatus. Professor H. F. Moore of the University of Illinois was in general charge of the work while Prof. J. B. Kommers of the same institution was engineer of tests and in immediate charge of them. The results of the tests have been made the subject of a report, *"An Investigation of The Fatigue of Metals,"* Bulletin No. 124 of the Engineering Experiment Station of the University of Illinois and acknowledgment is made to this publication for much of the information contained in the present article.

Quoting from the above bulletin the outline of the investigation was as follows: —

"At a meeting held February 19, 1920, the Advisory Committee planned reconnaissance tests of materials well scattered over the field of ferrous metals, in most cases studying two or more distinct heat treatments for each metal. It was decided not to enter the field of non-ferrous metals at this time.

"For each heat treatment of each steel tested it was planned to make a series of tests of specimens under reversed bending stress, using various stresses, until an "endurance" of 100,000,000 reversals was reached; to make corresponding static tests in tension, compression, and shear (torsion); and to make various auxiliary tests, including hardness tests and impact tests.

"It was planned to use magnetic analysis for examining the homogeneity of the material tested, and to study various accelerated tests for resistance to repeated stress in order to determine their reliability.

"The main purpose of this first stage of the investigation was to determine whether for ferrous metals there exists any clearly defined relation between the static properties (elastic limit, yield point, ultimate tensile strength, elongation, reduction of area, hardness, etc.) and ability to resist reversed stress.

"When later the General Electric Company became a party to the investigation there was added to this program the study of the effect of range of stress (stress partially reversed or repeated but not reversed, as well as stress completely reversed) upon the strength of ferrous metals under repeated stress. Work on this phase of the investigation has not passed the preliminary stage."

There have been several explanations or theories regarding the cause of failure by repeated stress. One of these, which has been fairly popular, was based on the theory that repeated stressing crystallized the material and caused it to fail, this theory resulting from observation of the fractured surfaces of parts that had broken under such conditions. Even with a material such as wrought iron the fracture appeared jagged and crystalline. All metals, however, as shown by the microscope are of a crystalline structure and this theory of crystallization has now been practically abandoned, at least by investigators in this field.

In this connection it will be interesting to quote a few paragraphs from Johnson's "Materials of Construction" relating to the fracture of wrought iron.

"Ordinarily when wrought iron is broken in tension in a testing machine the fracture appears to be wholly fibrous, somewhat like that of soft steel, but with a darker and more ragged appearance. If a wrought-iron bar be nicked and broken by bending, it will usually show a fibrous appearance, whereas steel so treated will always show a crystalline fracture. Occasionally, however, a part or all of the fracture of a test specimen of wrought iron, whether broken in tension or by nicking and cross-bending, will have a coarsely crystalline fracture. It is very common, also to find such a fracture when wrought iron breaks in service, as in the case of car and wagon axles, steam engine cranks and pins, etc. In such cases as these it has been common to ascribe the failure to the crystallized condition of the iron and to assume that the iron had changed to this condition in service. This is called the theory of the cold crystallization of wrought iron. Those who believe in it usually ascribe the change to a vibratory action."

"All wrought iron when broken with extreme suddenness will show a crystalline fracture. This is because time is not given for the drawing out of the section, rupture occurring directly across the fibres, so that the fracture shows only the end view of the same.

"When wrought iron breaks in service, therefore, and shows a coarsely crystalline fracture, it does not prove that crystallization has occurred in service. It proves only that this iron had such a structure originally. If, however, the rupture occurs in practice in a suddenly contracted area, as in a screw-thread or in a sharp angle, or if it has been produced with extreme suddenness, as in case of an explosion or shock of any kind, if the appearance of the fracture is finely crystalline or granular, this appearance may be wholly due to the method of failure. This is shown by the fact that if a specimen be cut from the adjoining metal and tested in tension with the standard form of specimen, it might show a wholly fibrous fracture. In such cases, therefore, the crystalline appearance of the fracture is due to the particular conditions as to shape of specimen and suddenness of rupture and not to any molecular change which has taken place in the iron."

A second theory which was advanced by Bauschinger stated that metals acquired new elastic limits under repeated stress and implied that some change took place in the nature of the material.

A third theory developed by the historical tests of Wohler, and stated by Gilchrist is as follows:

"(1) The average stress in the bars broken in Wohler's machines did not reach the statical breaking load.

"(2) The fracture was caused by the statical breaking limit being exceeded at one point only, from which, when once started, rupture spread, at first rapidly, then more slowly, sometimes continuing to complete separation of the two parts of the bar, but occasionally stopping short of complete rupture.

"(3) The raising of the stress at the point where fracture commenced was due to an irregularity in the bar. This might be an irregularity or discontinuity in the metal, either on the surface or in the body of the bar.

"(4) A bar of uniform strength whose surface was perfectly smooth, with no sharp corners in the longitudinal configuration and the structure of which was perfectly homogeneous would endure, without breaking, an indefinite number of repetitions of a stress varying between zero and a value near to the breaking strength.

"(5) A bar similar to that under (4) could, under certain conditions, endure an indefinite number of repetitions of a load varying between tension and compression of equal values both beyond the ordinary primitive elastic limits."

The third theory has been the most generally accepted and in remarking on it Professors Moore and Kommers say: —

"The writers agree in general with the foregoing statements, but, on account of the fact that a perfectly homogeneous material is not likely to be found for engineering purposes, they believe that the limitations of statement (4) as applied to ordinary metals should be set forth for the sake of clearness. It appears to them that the practical limit even for the case of stress varying from zero to a maximum will be the yield point of the material.

"This theory may be called the theory of non-homogeneity or of localized stress. The effect of external non-homogeneity due to scratches, tool marks, square shoulders, and notches is well known and is discussed in another section of this bulletin. Internal non-homogeneity may be due to blow-holes, pipes, inclusion of slag, irregularity of crystalline structure on account of the pressure of two or more constituents of varying strength, variation in orientation of crystals, or the presence of initial stresses caused by mechanical working or heat treatment. Owing to the minute area over which it exists, this localized stress produces no appreciable effect under a single load, but under load repeated many times there is started from this area a microscopic crack, at the root of which there exists high localized stress which under repetition of stress spreads until it finally causes failure.

"The writers do not look upon these fatigue failures as being due necessarily to accidental flaws or irregularities. Such failures may, in practice, often be due to such causes, but the definiteness of the endurance limits found in the present tests points to the conclusion that the endurance limit is a property of the material just as much as the ultimate strength. If in these tests the failure is due to flaws, then it is believed that these flaws are an inherent part of the structure of the particular steel which is being tested."

Although we have never seen it demonstrated we have heard it stated, in support of the crystallization theory, that a piece of unstressed steel if drilled will produce a long spiral ribbon, whereas the same steel after failure by fatigue will produce, when drilled, only short broken chips. This it was stated was proof of crystallization taking place. It would seem that this action could well be explained by the non-homogeneity theory and that the metal by repeated stressing had developed within itself a multitude of very small failures which initially did not exist.

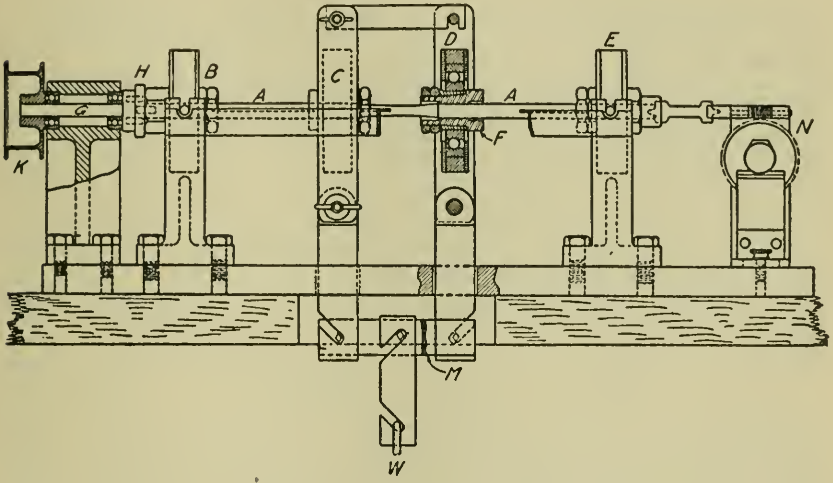


Fig. 1. Rotating Beam Testing Machine (Farmer).

A, Specimen to be tested; B, C, D and E, Ball Bearings; F, Draw-in collet for holding specimen in ball bearings, similar collets being used at each bearing; G, Drive shaft; H, Flexible leather disc; K, Drive pulley for connecting by belt to motor; M, equalizing bar; N, revolution counter which automatically stops when specimen breaks; W, support for weights by which specimen is stressed.

While a number of machines were used in making the reversed bending stress tests the one most used was the Farmer type, an outline of which is shown in Fig. 1. To insure the breaking of the test specimen close to the same part of its length in each test, the form shown in Fig. 2, page 104, was adopted. Tests were later run with other forms of reduction at the center and showed some very interesting facts which will be mentioned later.

Static tests in tension, compression and shear, and hardness and impact tests were also conducted on standard type machines.

The method of testing for the endurance limit by rise of temperature as suggested and carried out by Mr. C. E. Stromeyer* was also used.

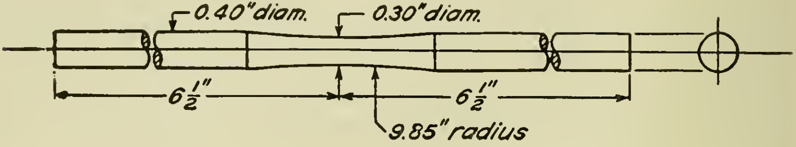


Fig. 2.

As stated in the University of Illinois Bulletin the fundamental information desired from the fatigue tests was the relation between the unit stress applied to the specimen and the number of cycles of stress necessary to cause rupture. The general practice with the Farmer machines was to stress the first specimen high enough so that it would break in a comparatively short time; then reduce the stress in the succeeding specimens, until finally a unit stress was arrived at which the steel could withstand for 100,000,000 cycles without failure. Wherever possible these long time tests without failure were run on from three to five specimens for each of the steels investigated.

Various methods of plotting or charting the results of tests of this nature have been used but the method adopted in the University of Illinois tests was to use logarithmic cross section paper. One of these diagrams is reproduced in Fig. 3. By using logarithmic cross section paper the results at a low number of repetitions of stress are magnified without unduly magnifying the results at a high number of repetitions. Furthermore, it was found that by this method the "endurance limit" was brought out at a very definite point.

Reference to Fig. 3 will show that the unit stress (S) to which the test specimen was subjected has been plotted in a vertical direction and the number of repetitions of this stress (N) which was necessary to bring about failure at a given stress has been plotted in a horizontal direction. These diagrams have been given the name of S-N curves or charts. It will be noted that at high stresses the value of N is relatively small but increases with a decrease of S until a certain value of S is reached when the line becomes practically horizontal indicating that at this stress the material could withstand, so far as these tests show, an indefinite number of repetitions of load. This value of S is known as the "endurance limit."

---

* See The Locomotive, January 1915, pg. 130.

As an illustration of the value of heat treatment the case of a .93% carbon steel may be mentioned. This steel was first "normalized" by heating to 1600° F., holding at that temperature for 15 minutes and then cooling in air. Test pieces of this normalized steel were then reheated to 1450° F., held at this temperature for 15 minutes and then gradually cooled in the heat-treating furnace. This developed a structure in the steel known as "pearlite" which showed an endurance limit of 30,500 pounds per sq. inch. By subjecting the "normalized" steel to a heat treatment consisting of heating to 1450° F., holding 15 minutes, quenching in oil, reheating to 1200° F., holding 30 minutes and then cooling in air, a structure known as "sorbite" was developed in the steel. This "sorbitic" steel was found to have an endurance limit 84% greater than the "pearlitic." By still a third treatment which developed a structure

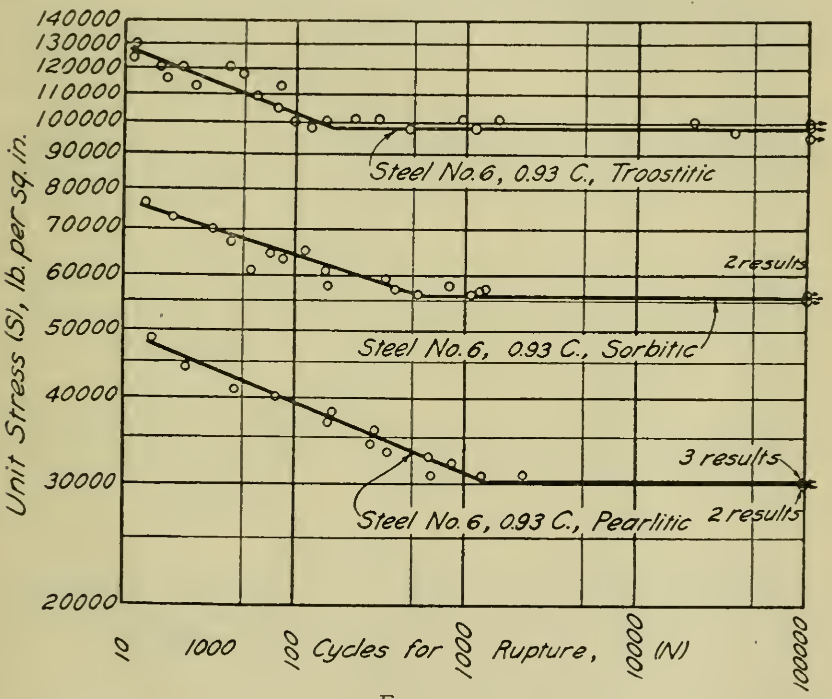


Fig. 3.

known as "troostite" the endurance limit was raised 221% above that of "pearlite." It was also shown that this increase in the endurance limit may be brought about with no serious loss of ductility.

It would be of immense value to be able to predict the endurance limit of a metal from results of a static test. Unfortunately, however, no relation seems to exist and upon further consideration this is not surprising. "The determination of the elastic limit and the ultimate strength depends upon the average properties of a considerable mass of material. A minute defect, such as a nick on the surface, an incipient crack in the structure, or a localized stress resulting from heat treatment, will not in general affect the determination to an appreciable extent. On the other hand, such a localized defect may readily act as a nucleus for structural damage which, under repeated stress, spreads in the form of minute cracks with continued localized stress present at the roots of these cracks, and finally causes failure."

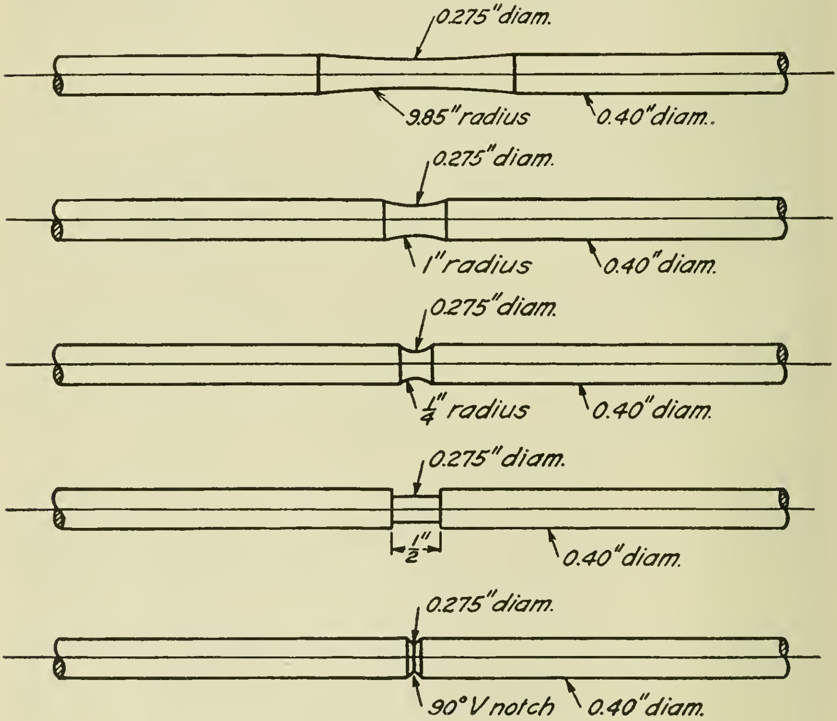


FIG 4. SHAPES OF SPECIMENS TESTED.

As is the case with the static tests so also there appears to be no relation between the results of impact tests and the fatigue strength. The Brinell hardness test, however, gives promise of great value although the reason for any consistent relation is not clearly understood.

COMPARISON OF ULTIMATE TENSILE STRENGTH AND ENDURANCE LIMIT OF SEVERAL STEELS

Steel	Ultimate Tensile Strength lbs. per sq. in.	Endurance Limit lbs. per sq. in.
0.02 carbon, as received	42,400	26,000
Hot-rolled, as received	61,500	28,000
Hot-rolled, reduced to 0.48 in.	67,600	35,000
Hot-rolled, reduced to 0.44 in.	73,400	41,000
Hot-rolled, bent cold and straightened		30,000
Cold-drawn, as received	86,800	41,000
Cold-drawn, annealed at 1300° F.	56,600	29,000
Cold-drawn, annealed at 1550° F.	57,700	25,000
0.37 carbon, normalized	71,900	33,000
0.37 carbon, sorbitic, treatment A	102,600	57,000
0.37 carbon, sorbitic, treatment B	94,200	45,000
0.49 carbon, sorbitic	96,900	48,000
0.52 carbon, normalized	98,000	42,000
0.52 carbon, sorbitic	111,400	55,000
0.93 carbon, pearlitic	84,100	30,500
0.93 carbon, sorbitic	115,000	56,000
0.93 carbon, troostitic	188,300	98,000
1.20 carbon, normalized	116,900	50,000
1.20 carbon, sorbitic	179,900	92,000
3.5 nickel, treatment B	111,800	63,000
Chrome-nickel, treatment A	138,700	68,000
Chrome-nickel, treatment B	113,300	65,000
Chrome-nickel, treatment C	114,200	67,000

Perhaps some of the most interesting results of the investigation are those which deal with the effect of the shape and the degree of finish given to the surface of the specimens. Test pieces of .49 carbon steel were made up as shown in Fig. 4 and tested in the Farmer machine. In the figure, the standard shape is shown also so that it may be compared with the others. The specimen with a 1″ radius appeared to be about as strong as the standard piece. Of the others, the ¼″ radius showed an endurance limit of 92%, the square shoulders

49% and the V-notch 40% of the endurance limit of the standard test specimen.

For the effect of the degree of finish on the surface of the specimen, five series of tests were run. "The five degrees of finish were: first, the standard finish, made with No. 0 and No. 00 emery cloth; the second, a high polish in which, after using No. 0 and No. 00 emery cloth, the specimens were polished with emery papers Nos. 1, 0 and 000, and finally with rouge and broadcloth, a microscope with a magnification of 100 diameters being used to make sure that all scratches were removed; third, a ground finish obtained with a grinding wheel; fourth, a smooth-turned finish with a lathe tool; and fifth, a rough turned finish with a lathe tool." "—— the rouge finish is probably slightly better than the standard finish in withstanding fatigue. The ground-finish endurance limit is slightly lower than the standard-finish, and the smooth-turned and rough-turned fall below the ground-finish in the order named. The rough-turned finish, the weakest, has an endurance limit about 18 per cent. lower than the rouge finish."

Approximate Service Required of Various Members of Structures and Machines Subjected to Repeated Stress

Part of Structure or Machine	Approximate Number of repetitions of stress in the "Lifetime" of the Structure or Machine
Railroad bridge, chord members	2,000,000
Elevated-railroad structure, floor beams	40,000,000
Railroad rail, locomotive wheel loads	500,000
Railroad rail, car wheel loads	15,000,000
Airplane engine crankshafts	18,000,000
Car axles	50,000,000
Automobile engine crankshafts	120,000,000
Lineshafting in shops	360,000,000
Steam engine piston rods, connecting rods and crankshafts	1,000,000,000
Steam-turbine shafts, bending stresses	15,000,000,000

While the authors feel that the investigation has not yet progressed to a point where a satisfactory formula may be stated for the relation between the intensity of stress and the repetitions necessary to cause failure, yet a great advance has been made and we feel sure that further study by such able investigators will bring results of still greater value.

Early Development of the Water Turbine.

POET and painter familiarized the populace with the picturesque water wheels along the streams of many countries, which but a generation or two ago, drove the machinery of small mills. For the most part, those wheels were of low efficiency. From them to the turbines of tens of thousands of horse-power which harness Niagara and many another " big drop," is a long step in water-power development. Poets have not yet learned the song of these new giants, with their allies, the modern electric generator and the high-tension transmission line, nor have painters yet made them picturesque. They are, none the less, full of poetry of achievement.

Early in the 19th century, French inventors produced turbines in which the water flowed in a direction generally parallel with the axis of the rotating part, or runner, and turbines in which the water flowed outward more or less radially through the runner. These simpler types could be used only for relatively small capacities and slow speeds. Then came the development in America of the inward flow type, the work of no one inventor. Samuel B. Howd, of Geneva, New York, patented such a turbine in 1836, which closely resembles the most modern types in its principle. While more compact and giving a higher speed than the French turbine, it was still a wheel of small capacity. James B. Francis, of Lowell, Massachusetts, improved its mechanical construction and efficiency.

Probably the greatest achievement of any one man in advancing the development of the hydraulic turbine was that of John M. McCormick, of Indiana County, Pennsylvania. He had a little sawmill on a small stream, and could run only a pondful at a time. The wheel was too large and used water so rapidly that it drew down the pond quickly and so curtailed operations. As in many other old sawmill wheels, there was no satisfactory way of reducing the quantity of water used. Like most early turbines and those of the present day as well, the water passages through the runners or buckets, as they are called, were narrower at the outlet than at the inlet to the wheel. McCormick conceived the idea that by still further extending the buckets he would make the outlets still narrower, thus choking the discharge, reducing the quantity of water used, and conserving the pondage. To accomplish this he riveted sheet iron extensions on to the outlets of the buckets, keeping the same form as the original passages but making them longer, narrower and more curved. To his great surprise and gratification he found that not only that the quantity of water used was reduced, but that in spite of using less water, the power of the wheel was considerably increased. This led him to further experiments.

About 1870, McCormick found that by extending the bucket vanes of an inward flow turbine downward and outward, making them ladle or spoon shaped, he was able greatly to increase the outlet openings of a turbine of a given diameter. At the same time, the length or depth of the inlet openings was proportionately increased, thus greatly increasing the capacity without increasing the diameter of the runner. Since the speed of a turbine decreases as the diameter increases, he thus produced a turbine of much greater capacity without reducing the speed. It was also found that the use of curved vanes providing for downward and outward flow, as well as inward flow through the runner, increased the efficiency since the water left the wheel in a direction opposite to that of the motion of the runner and so dropped away from the runner with little absolute velocity.

Not being able to analyze his intricate problem mathematically, McCormick depended upon his aptitude for mechanics, his keen observation and a sense of the action of the water in passing through the wheel. He worked on his wooden patterns with his own hands, making them express the results of his latest observation on trials of his wheels at the testing flume in Holyoke, or their performance in service. By trial and modification, he steadily advanced the efficiency of his turbines. His work was almost revolutionary. He laid the foundation for the great advances of recent years.

McCormick's designs were, however, arbitrary and each size or pattern was worked out by long and costly experimentation. Although the theory of the hydraulic turbine had been evolved mathematically many years before, it was never successfully applied to the design of turbines to meet specific conditions until after the advent of hydro-electric power transmission. The next step in the advance consisted in the modification of the combined-flow, or McCormick, turbine largely by means of theoretical deductions so as to adapt it to speeds, capacities and other conditions different from those for which the experimental designs were made. Furthermore, the growth in the size of units made the McCormick method of pattern-shop research no longer practicable.— *Research Narrative, Engineering Foundation.*

When we compare the relative size of the first McCormick turbine described above, which developed at most only a few horse-power, with the turbines used in some of the latest turbo electric installations where single units produce 55,000 H. P., there is food for thought on the tremendous development which, in the span of a single lifetime, has been brought about in the production and use of power. The very fabric of our modern civilization is dependent upon economical production of power. Those nations which are rich in coal or water power possess a great advantage in the race for commercial supremacy over nations which are not so blest.

A Notable Shipment of Locomotives.

IN the above title, reference is not made to this quarterly, The Locomotive, but to a shipment of twenty locomotives made by the Baldwin Locomotive Works for the Southern Pacific Railway, this shipment being only part of an order for fifty. This is the most remarkable single train of locomotives ever hauled across the country. The train itself was nearly half a mile long without the pulling and pushing engines and was known as " The Prosperity Special."

One of the Locomotives.

These locomotives are to be used in heavy freight service on heavy grades in the far West. They are carried on five pairs of driving wheels, with a two-wheeled truck at the front and rear. The large amount of weight on the driving wheels gives a great hauling capacity, while the trucks support the ends of the locomotive and guide it into curves and switches. Each locomotive is nearly 100 feet in length, weighing 621,000 lbs. so that the entire train of twenty weighed in excess of 6,000 tons. The tenders have cylindrical water tanks and a smaller tank at the front end to carry the oil fuel which all Southern Pacific locomotives burn. The oil is sprayed into the furnace by a jet of steam and the fire is controlled by means of valves placed within easy reach of the fireman.

Various modern devices are applied to increase the efficiency and capacity of the locomotives. Before entering the boiler, the feed water is heated; and the steam is also highly superheated before it enters the steam cylinders. An auxiliary engine known as a "booster" is attached to the rear truck for increasing the hauling power when starting heavy trains and climbing steep grades. The locomotive is reversed by a power operated device which relieves the engineer of considerable manual labor.

Throughout the entire journey, each locomotive was manned by an experienced engineer, who was personally in charge of the locomotive to which he was assigned.

"The Prosperity Special."

It was only possible to haul twenty of these heavy locomotives in a single train, and it required several pulling and pushing locomotives on level stretches, while in passing over the Allegheny Mountains west of Altoona, additional helping power was needed. No less than six engines were necessary to move the train around the Horse-Shoe Curve.

(Continued on Page 119.)

The Domestic Fuel Problem

Fuels are suitable for household use in the following order: anthracite, anthracite briquets, coke, bituminous briquets, low volatile "steam" coals (such as Pocahontas or New River), true bituminous or gas coals, lignite, peat and wood.

Coke is a clean burning and convenient fuel for household use and if available is a good substitute for anthracite, but there seems little prospect that much coke will be obtainable for household use this winter.

Anthracite briquets are a very satisfactory household fuel if well made and are now available in some localities.

Conditions in the coal mining industry for the past six months have been such that it seems impossible for a sufficient supply of anthracite to be available this winter for more than a small part of the house heating requirements of that portion of the United States which has been accustomed to use anthracite as a household fuel. It is probable, therefore, that to a considerable extent bituminous coal will have to be depended on for domestic requirements. Of course large numbers of people of this country are accustomed to the use of soft coal in their homes, but in the northeastern states where the clean smokeless burning anthracite has been the usual household fuel, there is a great hesitancy in turning to soft coal as a substitute. While many people will doubtlessly say they cannot burn soft coal as their heaters are not designed for its use, it is altogether probable that "when the days begin to lengthen and the cold to strengthen," they will be glad to burn any kind of fuel that is available. One result will be that if you burn soft coal your neighbor will have to put on a clean white collar oftener and his wife will have to change the lace curtains more frequently, but if your neighbor burns soft coal, then you and your wife will be the victims, for soft coal creates a social atmosphere and each time a furnace is coaled up in a community, the whole neighborhood will be made painfully aware of the fact. We shall likely be reminded of the condition which existed in 1902 when it was a common sight to see a finely dressed lady drive up to a City Hall in a coach and pair and take away her allotment of coal in a small bag. Sufficient unto the day is the evil thereof will hardly be said of coal this winter.

Knowing as we do that we are confronted by a decided shortage of fuel this winter, let us face this proposition, and as a man said when his wife's relations had been drafted into the war, "let us make the most of a bad situation."

The outstanding difference between bituminous coal and anthracite coal is that the former contains much more "volatile matter" than the latter. This volatile matter is that part of the coal which very readily changes to a gas when the coal is heated and if not quickly ignited and completely burned it will pass up the chimney largely as smoke. The conditions necessary to burn this gas are a high temperature so that it will be readily ignited and plenty of air well mixed with it so that combustion can be complete.

Bituminous or as it is more commonly known "soft" coal can be burned in household furnaces and heating boilers in a practical way. It is true that it may require more attention than hard coal and will make more dirt, but as long as there is a supply of soft coal available there need not be any real suffering from cold.

Of course coal dealers should endeavor to sell only lump coal for household use and let the slack be used as an industrial fuel. An even sized soft coal is better than a mixture of sizes. The soft coals best suited for household use are those low in volatile matter or smoke producing qualities such as the semi-anthracites or semi-bituminous coals and the lower the amount of volatile matter in the coal the smaller will be the amount of smoke in burning and the better the coal will be suited for household use. Some coals rather high in ash are more satisfactory for use in homes than others low in ash but high in smoke producing qualities, even though the latter coals may have a higher heat value.

While bituminous coals vary widely in composition, there are certain general rules which apply to the firing of all soft coals.

Better results are obtained by covering only part of the fire with soft coal at a time, always having a bright spot to ignite the gases which will be driven off from the coal by the heat shortly after fresh coal has been fired. For example, it is good practice to throw into the heater a few shovelsful of soft coal placing it so that it will be even with the door plate at the front of the firepot and sloping down at the back so as to leave a little patch of hot coals to ignite the gas and burn it. When this lot of coal has ignited far enough so that small flames are burning over the surface then more coal can be placed with the shovel at the back of the firepot so that there will be no hole left in the fire, but one should always be sure there are some hot coals or flame present to ignite the gas. This assures better economy with the fuel and cuts down the smoke and soot.

The gas which comes off from bituminous coal requires that more air be allowed to enter the space over the fire than is required by anthracite coal so that it is wise to open the draft in the door through which the coal is fired to permit air to enter. The amount that this draft must be opened will depend on the coal used.

It is safer to have a damper of the hinged door type in the smokepipe to act as an explosion door in case the gases in the smokepipe should become ignited on the way to the chimney. If such a damper is not provided the gas may ignite in the smokepipe and tear the latter loose from the chimney.

When preparing the fire for lasting over night or for a similar long period, it should be banked as follows: Cover part of the fire with coal as outlined above and open the drafts for a few minutes to let the coal become well ignited for perhaps half an hour. Then break up into large lumps the coke which has been formed and throw more coal on the fire, always leaving a bright spot to ignite the gases. After a few minutes more of active burning the fire can be checked for the night by closing the ashpit damper and checking the damper in the smokepipe. If the ashpit is tight the firing door can and should be kept closed or part of the heat of the fuel will be wasted in heating the cold air entering through the door above the fire. The quantity of fuel required to last over night and the adjustment of the draft dampers will vary with weather conditions and only trial under the actual conditions existing can determine what will be right.

Five ways of saving fuel in heating houses are suggested by Henry Kreisinger in Bureau of Mines *Technical Paper 199,* as follows:

1 — Of the coals available in your market select the one that requires the least attention in burning.

2 — Use an economical method of burning your coal.

3 — Keep your house temperature 62° to 65° F. instead of 72° to 75° F.

4 — Heat as few rooms as the comfort of your family will permit.

5 — Shorten the heating season as much as possible.

"INSTRUCTIONS FOR BURNING SOFT COAL IN THE HOME" is the title of a placard which The Hartford Steam Boiler Inspection & Insurance Company has published for posting near the boiler or furnace. Copies will be furnished free of charge upon application to the nearest branch office of this Company. For a list of these offices, see inside of back cover of this magazine.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, EDITOR.

HARTFORD, CONN., OCTOBER, 1922.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

"Have you heard of the wonderful one-hoss shay,
That was built in such a wonderful way
It ran a hundred years to a day,
And then, of a sudden, it ———,"

Thus did Oliver Wendell Holmes begin the description of The Deacon's Masterpiece, a chaise so built that each and every part was able to endure for exactly one hundred years. Then,—

"— it went to pieces all at once,—
All at once and nothing first,—
Just as bubbles do when they burst."

While we may have our doubts as to the wisdom of having all parts of a machine so designed, even were it possible, that they would all go at once with no previous warning, yet we cannot help but feel that some insight into the Deacon's store of superior knowledge, which made it possible for him to design his masterpiece, has been gained in recent years. With our present knowledge it would still be impossible to build a duplicate of the mythical "one-hoss shay" yet we feel quite sure that we are now more able to say *why* axles of wagons (it was this part of the "shay" that the poet felt was the weakest) and other vehicles break after varying periods of service.

"Fatigue of Metals" has been a subject of study for many years and a further contribution to the knowledge in this field has lately been made by a series of investigations carried on at the University of Illinois. An abstract of the report of these tests appears elsewhere in this issue.

The authors of the report suggest "progressive failure" as a better term than "fatigue failure." In view of the method by which machine parts are supposed to break under repeated loads, this term seems well chosen. We doubt, however, if there could be a more expressive term then "fatigue" for the unique failure of the "One-hoss Shay."

Gold Service Medals Awarded.

Many companies of high financial standing started in a very modest way and while their success has been due in some measure to the unusual opportunities which have presented themselves, yet the ability to recognize and grasp these opportunities has rested largely with the personnel of these companies. Therefore, those who have given long and faithful service to a company well deserve acknowledgment and special recognition. Recently, the Board of Directors of the Hartford Steam Boiler Inspection and Insurance Company, upon recommendation of the executive officers, authorized the preparation of a suitable gold medal, to be presented to those employees who had been connected with the company for 25 years or more, as a recognition of faithful service performed. After considering several designs submitted, a gold medal was adopted of which a facsimile of the face side is shown in the halftone herewith. One of these service medals was forwarded to each such employee with an appropriate letter by President Blake on or about July 1st.

The total number of employees who had been continuously with the company for twenty-five years or over was sixty-six, of whom 26 had been connected with the company for twenty-five to thirty years; 23 for thirty to thirty-five years; 11 for thirty-five to forty years; 2 for a period of forty to forty-five years and 2 for forty-five to fifty years. Two veterans of over 50 years service are Joseph McMurray of the New York Office who came with the company January 6, 1872, and

William J. Farran of the Philadelphia Office whose connection dates from December 31, 1869.

Three ladies who are numbered among those eligible for the service badge are Miss S. Jean Kerr and Miss Mary Thompson of the Chicago Office and Miss Cora E. Clark of the Boston Office.

Among those eligible to receive this medal was Mr. James G. Van Keuren, a special agent of the company in New York who was seriously ill at the time the medals were being distributed and who died on July 8, 1922. Fortunately the gold medal was received by Mr. Van Keuren several days before his death and the friendship and appreciation that it represented came as a comfort to him in his hour of trouble.

The medals came as a surprise to their recipients and that they were greatly appreciated is shown by the letters of acknowledgment received by President Blake. Interest in the medal led some of the staff connected with the company in more recent years to express a hope that time would find them eligible for one of these gold medals.

Obituary.

In the death of James G. Van Keuren at his home in New York City on July 8, 1922, the Hartford Steam Boiler Inspection & Insurance Company and the community in which he lived suffered a very real loss. He was in every sense of the word a Christian gentleman of the old school, remarkable for his hospitality and genuine interest in the welfare of all those about him. Once a friend he was always a faithful and interested one.

Mr. Van Keuren was born in Kingston, N. Y., in 1847, receiving his education in the public schools and at Kingston Academy. After connections with several mercantile firms he became, on August 21, 1893, a special agent in New York for the Hartford Steam Boiler Inspection & Insurance Company with which company he was associated at the time of his death. Up to the very end of his consciousness, his loyalty, strength and devotion were all for the Hartford Company by whom he was held in high regard and the agents, with whom he came in contact, were not only his loyal business associates, but warm personal friends as well. As a church member he was loyal and devoted to his duty, especially active in his work with young men in the Sunday School to whom he was a friend, advisor and comrade.

A Notable Shipment of Locomotives.

(Continued from Page 112.)

The departure of this complete train of locomotives, the most valuable ever moved in the country as a single unit, was a most memorable event at the works where they were built. Many distinguished men from Washington, all parts of Pennsylvania and adjoining States, including officials from the Southern Pacific and other railways of the country witnessed the starting.

By reason of the care which had to be exercised in the handling of this train, its movements were in the daytime only. No attempt at speed was made at any point, and this also permitted the train to be reviewed by millions of people throughout its long journey. At many of the stopping places and in a large number of cities through which it passed, State and Municipal authorities, officers and members of Chambers of Commerce, Boards of Trade, commercial and industrial organizations, public school authorities and local trade and business associations made arrangements to review the train as it passed through their localities. At the night stopping places, opportunity was afforded for a close inspection of the locomotives.

A Correction.

In the article "Mechanical Refrigeration and Refrigerants" which appeared in our last issue, a mistake has been noted on page 76. In the last sentence of the third paragraph on that page there occurs the phrase, "— it is possible to make the refrigerant change from a vapor to a gas —." The last few words of this should read, "— from a vapor to a liquid —."

Speaking of typographical errors, which, like the poor are always with us, reminds us of a newspaper report of a wedding. The statement was made that, "The roses were punk." In a later edition an apology was offered and was followed by the statement, "What we meant to say was, 'The noses were pink.'"

Caught in the Separator.

Boiler Gets Hot, Deserts the Scene.

An unusual accident happened at the J. A. Husky sawmill, four miles east of Blevins, Thursday. The boiler, a 35 horse-power stationary type, had been set in the furnace the day before and the mortar was not dry. A wooden manhead was substituted for the regular equipment so that the boiler might be steamed up partially and run the machinery for some light work. The head of steam rose above that intended. The manhead blew out and the boiler left the furnace, went 20 or 30 feet into the air and landed 150 feet away in a field across the pike. The machinery will be repaired and the mill will begin cutting within a few days.— *Arkansas Gazette, Little Rock, Ark.*

What's a little thing like a boiler explosion?

A Century Ago.

> " On Wednesday last of last week the boiler of the high pressure engine at Fair Mount [Phila., Pa.] burst directly over the furnace, through which, and the ash pit under it, the boiling water and steam were instantly discharged with great force into the boiler shed. R. Bingham, who attended the engine, and a person who had just stepped into the shed were severely injured. The former died on Saturday, and the recovery of the latter, who was removed to the Pennsylvania Hospital, is considered doubtful."— *National Gazette Oct. 18, 1820.*

Even in the "good old days" boiler explosions disturbed the serenity of the simple life.

More Yellow Peril.

One of our special agents, after investigating a prospect for boiler insurance, reports as follows: — " This Laundry is owned by a chinaman, Wing Kee. He says that business is too dull at present, but 'later on maybe so he catchum.' He has a little H. R. T. Boiler about 30″ x 10′. The negro fireman was sitting with his head up in the furnace to keep warm. A pressure of 35 lbs. was noted on the steam gauge and there was not a safety valve of any description to relieve pressure."

If the negro fireman should take his head out of the way and let the boiler absorb a little heat, Wing Kee might be more likely to "catchum" boiler explosion instead of more business.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF OCTOBER, 1921 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
408	8	Boiler exploded			Collis & Wagner	Tire Vulcanizers	Winchester, Va.
409	8	Syrup boiler exploded	1	1	Frank Stubbs		Covington, Ga.
410	9	Section of heating boiler cracked			Green Realty Co.	Hotel	Danbury, Conn.
411	9	Two tubes ruptured		3	Interstate Public Service Co.	Lighting Plant	Columbus, Ind.
412	10	Cast iron heating boiler cracked			Marz Theater	Theater	Tipton, Ind.
413	10	Steam valve exploded	1				Osceola, Fla.
414	10	Fire plate ruptured		3	Wm. Hendrick's Sons Co.	Lumber Mill	Buffalo, N. Y.
415	10	Section of heating boiler cracked			Julesburg Heating Co.	Heating Plant	Julesburg, Colo.
416	10	Section of heating boiler cracked			Electric Specialty Co.	Store	Stamford, Conn.
417	10	Heater manifold cracked			C. B. & A. J. Stevens	Greenhouse	Shenandoah, Ia.
418	10	Tubes pulled out	1		Central Texas Ice, Light & Power	Ice & Lgt. Mfg.	Mexia, Texas
419	10	Air tank exploded		1	Turner Bros.	Glass Works	Terre Haute, Ind.
420	11	Repair plug in boiler failed			Schmukler & Burstein	Apartment House	New York City
421	11	Section of heating boiler cracked			Wolfe Tavern Co.	Hotel	Newburyp't, Mass.
422	11	Boiler ruptured			Des Moines Ice & Fuel Co.	Coal Mine	Spring Hill, Ia.
423	11	Section of heating boiler cracked			Children's Aid Society	Home	New York City
424	11	Tank exploded	1	1	Birdsell Mfg. Co.		South Bend, Ind.
425	12	Fire sheet ruptured			Pulse & Porter	Power Plant	Hope, Ind.
426	12	Section of heating boiler cracked			School District No. 1	School	Plattsmouth, Nebr.
427	12	Tube ruptured			Sandusky Cement Co.	Cement Mill	Dixon, Ill.
428	12	Boiler exploded			Texas-Tamipo Oil Co.	Oil Well	Burnet, Texas
429	13	Boiler exploded			J. R. Best	Tailor Shop	Audubon, Ia.
430	13	Section of heating boiler cracked			L. E. Knott Apparatus Co.	Store	Cambridge, Mass.
431	13	Upper manifold cracked			Telegram Publishing Co.	Printing Shop	Holyoke, Mass.
432	13	Tubes ruptured			Edw. G. Budd Mfg. Co.	Auto Body Mfgrs.	Philadelphia, Pa.
433	13	Tube ruptured			Consumers Ice & Coal Co.	Ice Plant	Chester, Pa.
434	13	Boiler exploded		2	Odd Fellows Temple	Lodge Hall	Cincinnati, Ohio
435	14	Locomotive crown sheet ruptured		1	Henderson Land & Lumber Co.	Saw Mill	Fox Station, Ala.

MONTH OF OCTOBER, 1921 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
436	14	Section of heating boiler cracked			Feinberg Bros.	Store	Hartford, Conn.
437	14	Sections of heating boiler cracked			H. A. Metz & Co.	Laboratory	New York City
438	15	Sections of heating boiler cracked			Calvary Church	Church	New York City
439	15	Return drums of heater cracked			Piqua Bd. of Education	School	Piqua, Ohio
440	16	Boiler of locomotive exploded	1	1	B & O R. R.	Railroad	Sterling, Ohio
441	16	Sections of heating boiler cracked			Brenholts Realty Co.	Real Estate Dlrs.	Columbus, Ohio
442	16	Tire mold exploded			Meteor Tire Co.	Tire Factory	Chicago, Ill.
443	17	Tube ruptured			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
444	17	Boiler exploded		4	Mifflinsburg Body Co.	Auto Body Mfg.	Mifflinsburg, Pa.
445	17	Steam line ruptured			Proctor & Gamble Co.	Soap Factory	Ivorydale, Ohio
446	17	Boiler exploded		1	Michael Haas	Oil Well	Canaan, Ohio
447	17	Water heater exploded			Hugh Dougherty	Residence	Prospect Park, Pa.
448	17	Header cracked			The Peck Bros. Co.	Brass Plant	New Haven, Conn.
449	17	Tube pulled out of header		1	H. C. Frick Coke Co.	Coke Plant	Brownsville, Pa.
450	18	Blow off pipe failed			Elks City Ice, Fuel & Light Co.	Ice & Lt. Plant	Elk City, Okla.
451	18	Boiler exploded			Abraham Shoul	Residence	Manchester, N. H.
452	19	Blow off valve failed		3	Hartburg Lumber Co.	Lumber Mill	Hartburg, Tex.
453	19	Boiler exploded		1	South Penna Oil Co.	Oil Producers	Kane, Pa.
454	20	Tubes ruptured			Utah-Idaho Sugar Co.	Beet Sugar Mill	Payson, Utah
455	20	Section of heating boiler cracked			Dora Soloway	Hotel	Bridgeport, Conn.
456	20	Section of heating boiler cracked			Chevrolet Motor Co.	Auto Factory	New York City
457	21	Tube failed			Howard D. Brewer	Wholesale Drgst.	Fall River, Mass.
458	21	Section of heating boiler cracked			Leopold Sinsheimer	Store	New York City
459	21	Header cracked			Pittsburg Plate Glass Co.	Glass Works	Creighton, Pa.
460	22	Boiler bulged and ruptured			A. F. Sievert	Power Plant	Warrenton, Mo.
461	22	Boiler flue exploded		1	Soisson Fire Brick Co.	Brick Plant	Latrobe, Pa.
462	22	Section of heating boiler cracked			Colonial Apt. House Co.	Apartment House	Omaha, Nebr.
463	22	Boiler tube exploded	2	1	Naval Training Station	Steam Launch	San Francisco, Cal.
464	23	Sections of heating boiler cracked			The Lathrop Co.	Store	Hartford, Conn.
465	23	Sections of heating boiler cracked			Sam Harris	Apartment House	San Francisco, Cal.
466	24	Sections of heating boiler cracked			Florence G. McKeever	Loft Bldg.	New York City
467	25	Section of heating boiler cracked			Geo. W. Trant	Residence	New Britain, Conn.
468	25	C. I. Boiler cracked			Pinehurst Hotel	Hotel	Laurel, Miss.

469	26	Header cracked			Pittsburgh Plate Glass Co.	Glass Works	Creighton, Pa.
470	26	Boiler of locomotive exploded	1	4	Phila. & Reading R. R.	Railroad	Milton, Pa.
471	27	Heater manifold and section cracked			Jos. J. Cohen	Apartment House	Philadelphia, Pa.
472	27	Air tank exploded			Gambel & Shutes	Garage	Phoenixville, Pa.
473	28	Sugar evaporating tank exploded	1	4	American Beet Sugar Co.	Sugar Refinery	Rocky Ford, Colo.
474	28	Boiler tube exploded	1		City Water Works	Pumping Plant	Canton, O.
475	28	Sections of heating boiler cracked			N. N. Rogers, Sr.	Hotel	Post, Texas
476	30	Sections of heating boiler cracked			J. S. Doane	Hotel	Bryan, Texas
477	31	Tube ruptured			Lehigh Portland Cement Co.	Cement Mill	Allentown, Pa.
478	31	Steam header failed			Columbus, Newark & Zanesville Elec. Ry. Co.	Power Plant	Hebron, O.
479	31	Shell bagged and tube pulled out			Hadfield-Penfield Steel Co.	Clay Machinery	Willoughby, O.
480	31	Tubes failed			American Steel & Wire Co.	Steel Plant	Waukegan, Ill.

MONTH OF NOVEMBER, 1921.

481	2	Furnace sheet bagged and ruptured			The American Steam Laundry	Laundry	Washington, Ind.
482	2	Two sections of heating boiler cracked			The Independent School	School	Denison, Ia.
483	2	Boiler exploded			Milledgeville Water Co.	Pumping Sta.	Milledgeville, Ill.
484	3	Boiler exploded			Pratt Oil Co.	Oil Well	El Dorado, Ark.
485	4	Boiler exploded			National Contracting Co.	Contractors	Oliver, Ky.
486	4	Kier exploded		3	J. F. Bast Knitting Mills	Knitting Mill	Sch'kill Haven, Pa.
487	4	Boiler exploded			Wood Bros. & Chamberlain	Silage Cutters	Bowling Green, O.
488	4	Crown sheet collapsed		1	Shroeder & Aasen	Lumber	Norway, Ore.
489	4	Two tubes pulled out of bottom tube sheet			Morton Salt Co.	Salt Mfgrs.	Port Huron, Mich.
490	5	Section of heating boiler cracked			Neighborhood Guild Ass'n	Social Settlement	Columbus, Ohio
491	5	Fire sheet bulged			Merritt Mercantile Co.	Cotton Gin	Black Oak, Ark.
492	5	Boiler exploded			Montgomery Slaughter House	Abattoir	Montgomery, Ala.
493	6	Front shell of boiler corroded and blew out			Estate of Bernard Marmande	Sugar Mfgrs.	Theriot, La.
494	7	Three sections of heating boiler cracked			T. D. Cook & Co., Inc.	Restaurant	Boston, Mass.
495	7	Air tank exploded		1	U. S. Pipe Bending Co.	Pipe bending	San Francisco, Cal.
496	8	Blow off pipe failed			Piqua Hosiery Co.	Hosiery Mfgrs.	Piqua, O.
497	8	Locomotive exploded	3		Texas & Pacific R. R.	Railroad	Abilene, Texas
498	9	Two sections of heating boiler cracked			Cuba-Connecticut Tobacco Co.	Tob. Warehouse	Agawam, Mass.
499	9	Sections of heating boiler cracked			Lillian Palmer & May Stevens	Apmt. House	San Francisco, Cal.
500	10	Fire sheets of boiler bulged			Miners Ice & Fuel Co.	Ice & Storage	Joplin, Mo.

MONTH OF NOVEMBER, 1921 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
501	10	Bottom plate cracked			The Wells Memorial Ass'n	Business Bldg.	Boston, Mass.
502	10	Tube pulled out of bottom drum			Delta Ice & Cold Storage Co.	Ice & Storage	Vicksburg, Miss.
503	10	Crown sheet collapsed			S. F. & Mrs. Julie Gianelloni	Sugar Mfgrs.	Burtville, La.
504	10	Boiler exploded		2	Hikell Mfg. Co.		Omaha, Neb.
505	11	Boiler exploded	1			Saw Mill	East Prairie, Mo.
506	11	Section of heating boiler cracked			Boys' Home	Boys' Home	Cincinnati, O.
507	12	Furnace sheet bagged and ruptured			City of Providence	Elec. Lgt. Plant	Providence, Ky.
508	13	Pipe fittings failed			West Penn Power Co.	Power Plant	Connellsville, Pa.
509	14	Headers cracked			Indian Refining Co.	Oil Refinery	Lawrenceville, Ill.
510	14	Steam pipe burst	1		American Tubes & Stamping Co.	Metal Works	Bridgeport, Conn.
511	15	Boiler exploded	1	1		Oil Well	Mexia, Tex.
512	15	Section of heating boiler cracked			Town of Milford, Conn.	Town Hall	Milford, Conn.
513	15	Tube ruptured			American Steel & Wire Co.	Steel Works	Waukegan, Ill.
514	16	Tube failed			Malone Paper Co.	Paper Mfgrs.	Malone, N. Y.
515	16	Header cracked			Pittsburg Plate Glass Co.	Glass Mfgrs.	Crystal City, Mo.
516	17	Section of heating boiler cracked			Piqua Piggly Wiggly Co.	Store	Piqua, Ohio.
517	17	Crown sheet bagged		5	Erlanger Cotton Mills Co.	Cotton Mill	Lexington, N. C.
518	17	Tube failed			D. C. Sheppard	Wholesale Milnry.	St. Paul, Minn.
519	18	Three double sections of heating boiler burned out and one cracked			The Lunkenheimer Co.	Valve Mfgrs.	Cincinnati, O.
520	18	Boiler exploded		1	E. W. McClellan	Nursery	Burlingame, Cal.
521	18	Hot water heating boiler exploded			Wm. T. Bates Co.	Boiler Mfgrs.	Norristown, Pa.
522	19	Hot water front exploded			S. Larison	Residence	Butte, Mont.
523	19	Three sections of heating boiler cracked			John R. Thompson	Restaurant	Atlanta, Ga.
524	19	Tube ruptured			Pittsburgh Plate Glass Co.	Glass Mfgrs.	Creighton, Pa.
525	20	Section of heating boiler cracked			Pelham Health Inn	Hotel	New York, N. Y.
526	20	Two headers cracked			Kingston Coal Co.	Coal Mines	Kingston, Pa.
527	21	Section of heating boiler cracked			Gotham Can Co.	Can Mfgrs.	Brooklyn, N. Y.
528	21	Front header cracked			Diamond Alkali Co.	Alkali Works	Fairport, O.
529	21	Section of heating boiler cracked			Hampden Lodge I. O. O. F.	Assembly Hall	Springfield, Mass.
530	23	Four sections of heating boiler cracked			Ephraim Siff	Mercantile	New York, N. Y.
531	23	Boiler exploded	2		William S. Wilson	Oil Well	Dillard, Okla.
532	24	Boiler exploded	1	1	James Coggin	Saw Mill	Biscoe, N. C.

533	24	Boiler exploded	1		Luther Hudson	Mill	Tishomingo, Miss.
534	25	Boiler exploded			Red Men's Hall	Assembly Hall	Greenwich, Conn.
535	26	Boiler exploded	4	2	Connie Mayer	Saw Mill	Eastman, Miss.
536	28	Exhaust line failed			American Printing Co.	Cotton Mill	Fall River, Mass.
537	28	Furnace sheet bagged and ruptured			Warrick Coal Mining Co.	Coal Mines	Boonville, Ind.
538	28	Circulation pipe of boiler failed		1	Durham Hosiery Co.	Hosiery Mfgrs.	Durham, N. C.
539	28	Section of heating boiler cracked			Bd. of Education	School	Newton, Kan.
540	28	Boiler exploded			May Farm	Oil Well	Port Huron, Mich.

MONTH OF DECEMBER, 1921.

541	1	Section of heating boiler cracked			Meserole Exhibition Co.	Theater	Far R'kaway, N.Y.
342	1	Tube ruptured			City of Baltimore, Md.	Hospital	Baltimore, Md.
543	1	Blow off pipe failed			Providence Drysalters Co.	Chemical Works	E.Greenwich,R.I.
544	2	Boiler exploded	1	1	Green Valley Mills		Cambridge, Md.
545	2	Boiler shut off valve burst		7	Steamship Everett	Steamship	East Boston, Mass.
546	2	Boiler exploded	2			Oil Well	Wilson, Okla.
547	3	Six sections of heating boiler cracked,					
548		four others warped			East Market Hotel Co.	Hotel	Akron, O.
549	4	Section of heating boiler cracked			R. C. Church of Ascension	Church	New York, N. Y.
	5	Middle section of heating boiler cracked			Mutual Garage & Auto Co.	Garage	Norwood, O.
550	5	Boiler explosion	1		Leak & Shepley Sugar Co.	Sugar Plant	Culiacan, Mexico
551	6	Boiler of locomotive exploded	1	1	Pennsylvania R. R. Co.	Railroad	Peters Creek, Pa.
552	6	Four sections of heating boiler cracked			Board of Education	School	Beckley, W. Va.
553	7	Heating boiler exploded			Henry A. Strong	Residence	Rochester, N. Y.
554	7	Blow off failed			William H. Casey	Hotel	Milford, Mass.
555	7	Eleven half sections of heating boiler					
556		cracked			Second Congregational Society	Church	Holyoke, Mass.
557	9	Boiler of locomotive exploded		2	Houston & Texas Central R. R.	Railroad	Forth Worth, Tex.
	9	Mangle exploded		1	Regal Sack Co.	Bag Mfgrs.	Jersey City, N. J.
558	8	Circulating tube ruptured			The Thomas Co.	Blast Furnace	Hokendauqua, Pa.
559	8	Four sections of heating boiler cracked			John R. Thompson	Restaurant	G'd Rapids, Mich.
560	8	Boiler exploded		1	Attleboro Manufacturing Co.		Attleboro. Mass.
561	9	Boiler exploded	1	1	Bruno M. Granz	Milk Plant	Bedford, N. H.
562	9	Heating boiler exploded			Kate Shaefer	Residence	St. Louis, Mo.
563	9	Section of heating boiler cracked			Holyoke Bar Co.	Paper Makers Bars	Holyoke, Mass.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1922

Capital Stock, . . $2,000,000.00

ASSETS

Cash in offices and banks	$492,329.45
Real Estate	150,000.00
Mortgage and collateral loans	1,673,850.00
Bonds and stocks	6,429,307.52
Premiums in course of collection	766,619.61
Interest Accrued	120,981.61
Total Assets	$9,633,088.19

LIABILITIES

Reserve for unearned premiums		$4,602,639.11
Reserve for losses		213,814.87
Reserve for taxes and other contingencies		396,621.24
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,420,012.97	
Surplus to Policy-holders		**$4,420,012.97**
Total liabilities		$9,633,088.19

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President and General Counsel.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.

BOARD OF DIRECTORS

ATWOOD COLLINS, President, Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Bank, Hartford, Conn.
MORGAN B. BRAINARD, Vice-Pres. and Treasurer, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Ass't Treas., Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Company.
SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.

Incorporated 1866. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLYWHEEL EXPLOSIONS AND ENGINE BREAKAGE

Department	Representaeives
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, Ct., 405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. E. Mason Parry, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'l'v'd	J. F. Criswell, Manager. P. M. Murray, Ass't Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	A. Paul Graham, Manager. L. T. Gregg, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J. H. Chesnutt, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, General Agent. E. Mason Parry, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnett, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickham, Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrott Bldg.	Geo. S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	McCargar, Bates & Lively, Gen'l Agents. C. B. Paddock, Chief Inspector.
SEATTLE, Wash., 540 New York Block	C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, President. The Boiler Inspection and Insurance Company of Canada.

CARNEGIE LIBRARY
PITTSBURGH, PA.

Where Are Your Dollars Going;

Into useful steam or up the stack?

Your Coal Pile May Be Wasted

or conserved by the firemen in the boiler room. Which it will be depends on how much they know about the principles of combustion.

Many Concerns Have Found

the *Hartford Correspondence Course for Firemen* a valuable aid in educating the man who handles the coal how to save fuel and how to give the boiler the attention it requires.

Fill out the blank below and let us send you further information.

....

The Hartford Steam Boiler
Inspection & Insurance Co.,
Hartford, Conn.

Please send me further details of your Correspondence Course for Firemen.

Name ....

Address..

....

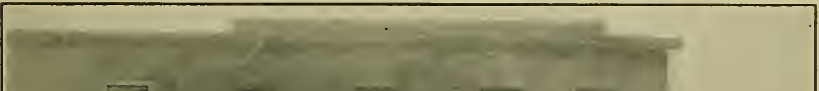
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIV. HARTFORD, CONN., JANUARY, 1923. No 5.

COPYRIGHT, 1923, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



BOILER EXPLOSION AT A LOUISIANA COTTON OIL MILL.

THERE IS VALUABLE INFORMATION FOR YOUR ENGINEER IN THIS MAGAZINE. PLEASE LET HIM SEE IT.

A Boiler Explosion at a Louisiana Cotton Oil Mill.

THE picture on the front cover of this issue of The Locomotive shows the extensive damage resulting from the explosion of a boiler, which occurred on September 22, 1922 at the plant of the South Texas Cotton Oil Co., Eunice, La., causing a loss of $15,000. The boiler which exploded was one of a battery of three housed in a brick building. Two of them were H. T. boilers 60″ x 18 ft. and twenty years old with double riveted lap seams and one was a 66″ x 16 feet H. T. boiler with triple riveted butt seam and approximately twelve years old. It was one of the first two boilers mentioned that exploded.

The power plant was badly wrecked by this explosion, the engine, generator, and pumps being damaged so that considerable repairs will be required to place them in working condition. The boiler house structure was completely demolished and the mill building itself was injured and the windows blown in.

The accident occurred at 4 A. M. and was apparently due to low water. The initial fracture extended along the entire right side of the boiler at a point about 10″ below the longitudinal seam and the boiler sheet almost completely unwrapped, pulling off the rivets of both head seams and flattening out. Both heads broke through the top row of tubes. The edges of the shell where the fracture occurred were drawn out to knife edges along the front half of the boiler. The settings of all three boilers were completely destroyed including the cast iron front and connections. The auxiliary piping of all three boilers was demolished and scattered. Oil fuel was used under these boilers and the oil burners, piping and oil feed pumps were badly damaged.

Two water supply tanks of ⅛″ steel, 10 ft. in diameter and 12 ft. high which were located outside of the boiler room on an elevated platform about 20 ft. from the ground were knocked down and the platform demolished. The fireman on duty at the time of the explosion had been employed at the plant only seven weeks and he received injuries from the accident which caused his death.

Fortunately for the owners, the loss resulting from the explosion was covered by a boiler explosion insurance policy with the Hartford Steam Boiler Inspection & Insurance Company and a settlement was promptly reached.

The Corrosion of Iron and Steel.

By Charles L. Wright

IRON is the most important metal of our modern times. In prehistoric times, man used tools chipped by great patience from stone to carry out his crude work. Copper and bronze or brass may have been used at as early a period as iron, and for many centuries after their use began they undoubtedly superseded iron to a large extent, but the common theory that there was a copper or bronze age before iron was either known or used is discredited by Old Testament history, by literature of the ancient Greeks and Chinese and by discoveries of modern antiquarians. Iron was first used in Western Asia, the birthplace of the human race, and in the northern parts of Africa near Asia.

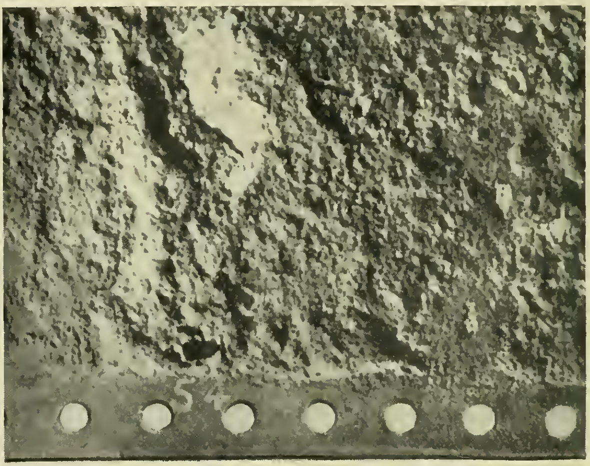
Modern civilization itself is closely allied with the development of the iron industry and it is hard to see how our present attainments could have been reached without an abundant supply of cheap iron. The railroads, the steamships, the modern skyscrapers and the extensive industrial plants all depend to a large extent on the use of iron and steel. In our homes the stoves, furnaces and the plumbing equipment, all constantly remind us of our dependence on iron. As iron is so universally important, anything which will help to conserve it and lengthen its usefulness merits our interest and careful attention. Like all animate or inanimate matter, iron is subject to decay, which takes the form of corrosion or rusting and this if not checked will in time destroy the iron to an extent that will impair its usefulness. It is the object of this article to discuss some of the causes of corrosion, the conditions favorable to corrosion and means of protecting iron from destruction by rust.

The rusting of iron has been attributed to various causes. Some of these causes are; (1) — dissolved gas or gases in the water, (2) — free acids in the water — the acids being usually organic, (3) — galvanic action and (4) — colloidal action.

The results of some of the earlier investigations of corrosion follow:

Andes in his book "Der Eisenrost" says, "Rust is formed by air, water, all organic and inorganic acids, all combinations of chlorine and a metal (alkali earth), and all crystalline or water attacking salts." Hoffman in "Notes on Iron and Steel" says, "Iron exposed to action of moist air, oxidizes, forming rust, hydroxide or iron containing more or less ferrous carbonate. To cause rust, oxygen, carbon dioxide and water must be together. Iron will also rust if the CO_2 is replaced by other acids or certain salts (alkali chlorides)."

Remsen in his "Inorganic Chemistry" says, "In dry air iron does not undergo change, but in moist air it rusts, or it becomes covered with a layer of oxide and hydroxide, which is formed by the action of the air, carbon dioxide and water. Water that contains salts in solution facilitates the rusting." Sabin in his treatise "Painting to Prevent Corrosion" says that if oxide is not cleaned off before painting iron, the rusting will continue under the paint.



A Corroded Boiler Plate.

A chemist of Hanover, Germany, claims to have prevented corrosion on the inside of a boiler by painting the inside of the shell with caoutchouc oil. Spnurath claims to have proven the action of CO_2 on iron in the presence of air but he says that CO_2 will not act in the absence of air. Lennan states that wrought iron boiler tubes were less corroded by a certain water than steel tubes. He further states that he found corrosion was caused by the oxygen dissolved in water. Professor Cohen states that by his experiments he found that chemically pure copper was only corroded by sea water when atmospheric air could co-operate in the action and that the removal of the CO_2 caused the corrosion to cease. It is probable that conditions favorable to corrosion of copper would also be favorable to corrosion of iron. Adams thought bicarbonate of iron was formed by the action of CO_2 on iron, this bicarbonate decomposing to form the carbonate. He also proved that hydrogen is formed by the action of iron on hot water.

It was thought that the action of pure oxygen on iron in water was to produce practically insoluble oxide, in which case the corroding force of oxygen containing water might be very slight. If an acid capable of forming a soluble salt with the iron were present, active corrosion should be much more rapid. Carbonic acid is the only acid to be expected in most natural waters and this acid will always be present to at least some extent in all waters. Therefore the action of this acid is most important. It is known that water containing carbon dioxide dissolves lime to form calcium bicarbonate and that heat will decompose this double salt in solution setting free half of the carbon dioxide, the remainder precipitating with the lime as calcium carbonate. In cases of hot water and steam heaters a condition exists where a parallel set of reactions might be expected between iron and carbonic acid solution. Here soluble ferrous bicarbonate could be formed in cool or moderately warm parts of the system which might decompose on boiling as does the corresponding calcium salt. This decomposition could yield at least half of the original carbon dioxide which driven with steam from the boiler could act again on more iron in cooler parts of the system. It was thought also that if the ferrous bicarbonate did not break up on heating the solution beyond the formation of precipitated ferrous carbonate this in turn might be oxidized to ferric oxide, by air in the feed water. On the other hand, owing to the difference in solubility of calcium hydrate and ferrous hydrate, the production of ferrous hydrate as a product of heating a solution of ferrous carbonate was also a possibility. In either of these two cases a little carbon dioxide once enclosed within a heating system having high and low temperature at different points (as is always the case in practice) would be capable of dissolving and removing an infinite quantity of iron from the cooler parts precipitating it as ferrous or ferric oxide in the hotter parts.

In the process of corrosion, iron is converted by combination with moisture and oxygen into a hydrated ferrous sesquioxide or rust which is of a brown, reddish or yellowish-brown color. In the presence of water, the darker colored oxides are formed. Rust is granular and amorphous in character rather than crystalline.

Observation shows that rust does not take place evenly but is apt to occur in little spots or pits which by growth and extension finally cover the entire surface. In view of this fact, there is ground for truth in the slogan of the paint manufacturers, " Save the Surface and you Save All," or in other words the best way to avoid the harmful results of corrosion is to prevent its beginning. In order to accomplish this we must have some understanding of the underlying causes of corrosion. Several theories have been advanced as to why iron rusts and in using the term iron we include steel, its combination with carbon. The more important of these theories of corrosion are the chemical or carbonic acid theory, the electrolytic theory and the colloidal.

According to the carbonic acid theory, the iron is supposed to be attacked by carbon dioxide in the presence of moisture converting the iron into a carbonate and releasing hydrogen, which unites with the oxygen present as air or otherwise, to decompose the ferrous carbonate to ferrous hydroxide or rust, leaving the same amount of acid as was originally present to react again with more iron and form more rust.

According to this theory a single molecule of carbon dioxide would be sufficient in the presence of air and moisture, to carry on corrosion in a cycle. The carbonic acid, due to the combination of the carbon dioxide with water, would, by its action, put iron into solution; and this is all that is necessary to corrosion, the dissociated iron being oxidized to rust in the presence of oxygen. If, however, this residual gas in water cannot be removed by physical means as by boiling, it can perhaps be expelled by chemicals; even then it is possible that a definite degree of concentration of the acid neutralizer would have to exist; which would explain the rusting of iron in weak alkaline solutions.

Careful experiments indicate that corrosion will take place even in the absence of carbonic acid, although it is without doubt an aid to corrosion.

Carbon dioxide will act on iron to cause corrosion even when no air is present. Apparently the part water plays in corrosion is as a carrier of the dissolved gases which react with the iron.

Therefore, according to the acid theory of corrosion, an acid must be present, especially carbonic, to act chemically on the iron to form a soluble ferrous salt that is later on oxidized to a more stable ferric hydrate or rust and the acid radical is liberated for further attack on the iron.

Whitney's experiment in 1903 demonstrated that iron could be left submerged in distilled water, from which the air had been expelled by boiling and then sealed in glass tubes, for several weeks without corrosion of the iron being apparent on the surface or any evidence of corrosion product in the water or on the glass. When these sealed tubes were opened at the end of several weeks and air admitted, a precipitate of ferric hydrate or rust quickly settled out. This experiment indicates that iron dissolved in the water until a saturated condition was reached and the dissolved iron precipitated out of solution by the action of the oxygen of the air. He therefore concluded that iron went into solution in the absence of oxygen and for this reason he concluded that corrosion was an

Boiler Explosion Caused By Corrosion.

electrolytic action rather than a chemical action.

According to this electrolytic theory, when any two substances of different polarity are immersed in a suitable electrolyte or medium containing free ions of matter, an electric current is set up between these two electrodes and the substance from which the current flows tends to dissolve. In applying this theory to corrosion, the pure iron would act as one eletrode while any impurity in the iron would act as the other and the iron would be considered to dissolve in water or moisture as ferrous ions and any free oxygen present would oxidize the iron while the latter was in this dissociated condition. Dr. Cushman, who carried out an elaborate set of investigations on the subject of corrosion, states, "If, therefore, we immerse a strip of iron in a solution (containing hydrogen ions), iron will go in solution and hydrogen will pass from the electrically charged or ionic to the atomic or gaseous condition. In such a system the solution of iron and therefore its subsequent oxidation must be accompanied by a 'precipitation' or setting free of hydrogen. It is well known that solutions of ferrous salts as well as freshly precipitated ferrous hydroxide are rapidly oxidized by the free oxygen of the air to the ferric condition, so that if the electrolytic theory can account for the original solution of the iron the explanation of rusting becomes an exceedingly simple one."

Sang believes that it is not correct to say that iron corrodes only when anode or positive electrode and he believes that ordinary iron corrodes whatever the galvanic position of the mass may be in reference to its surroundings.

It has been found that metals absorb gases to some extent. Graham found that iron cooled in hydrogen absorbed 46% of its volume. Other investigators have found that hydrogen was present in iron. This condition is important because, hydrogen being negative to iron, it will as already stated, promote its solution and corrosion.

To drive the gases out of pig iron a temperature of 1500° F. is sufficient. Malleable iron contains more carbonic acid than hydrogen and it is retained with greater energy. Steel is said to absorb somewhat less than cast iron, and wrought iron less than cast iron; these differences being without doubt, functions of the porosity.

Occluded gases and especially hydrogen, must not be lost sight of when dealing with the problem of corrosion. Hydrogen is the lightest and therefore kinetically the most active of the elements and it is the only element in the presence of which all chemical reactions will take place. Hydrogen will pass through platinum and red hot iron, and there is reason to believe that under conditions of common occurrence, it will break down into free and active atoms ready to combine with other substances at the first opportunity.

The principal difference between iron and steel lies in the carbon content and methods of manufacture. Chemically speaking, there is no sharp line of demarcation between iron and steel but as they are made by different processes, they therefore have different physical properties. Steel can be hardened by changes in the carbides but chilled iron is hard because of a change in the structure of the surface from crystalline to amorphous, or nearly so.

When in a normal condition iron and steel have a crystalline structure, and a so-called fibrous texture is due merely to a series of crystals pulling out of the mass when a fracture takes place. The slower and more uniform iron and steel are heated and cooled, the smaller and more regular will be the crystalline structure of the metal. Apart from the chemical and voltaic causes, corrosion will vary according to the structure of the material and the mechanical treatment it has received.

A Corroded Stay.

Hard cast-iron is less corrodible than soft cast-iron of similar composition and it corrodes faster if cooled irregularly than if cooled uniformly and slowly. The more porous the material the more rapidly will corrosion proceed and the deeper and more distinctive will it be. Blowholes of any size invite rust. Metals of crystalline structure are better conductors of electricity than amorphous, and this may account for the fact that some rolled sheets are more durable than others. Those which have had careful annealing or heat treatment would have the more crystalline structure.

It has been demonstrated that iron and steel are porous microscopically speaking and under high pressure (as in hydraulic pressure cylinders), water may be forced through thin walls in amounts sufficient to show as beads of "sweat." Gases are absorbed into this porous structure. At high temperatures all metals absorb gases, losing part of them on cooling.

Corrosion is aided by the mixture of impurities into iron and as corrosion is one of the frequent causes of boiler explosions, sometimes involving the loss of life and the destruction of thousands of dollars worth of property, therefore only the best of materials should be used in the construction of boilers.

The amount of stress on a piece of iron or steel effects its liability to corrosion. Experiments have shown that in all classes of tests, tensile, torsional and flexional, the results will be similar; that is to say, that galvanometer readings show the strained parts to be electro-negative to the unstrained parts and therefore more liable to corrosion. Other experiments have shown that if iron or steel are strained beyond their elastic limit, those lines of action of the force applied are made more porous and are therefore more subject to corrosion.

Investigations therefore seem to prove that the mechanical treatment a metal is subjected to will set up unequal strains in different parts of the finished pieces that will result in unequal potential thus promoting corrosion. Action, power, everything that is known, varies with differences in potential and any chemical or physical difference between two portions of a substance in contact with each other will always cause a difference in potential and a flow of electricity.

Furthermore, it has been found that chilling or hardening steel or iron has the same effect in developing a difference in potential because strains are set up by this process. Soft steel is much more subject to corrosion than hard steel.

As steel is negative to iron it ought to corrode less than iron under the same conditions. The results of recent investigations would seem to indicate that properly protected iron and steel show little difference in their tendency to corrode, but difference in structure and chemical composition do affect either of them. This, of course, refutes the idea that has been accepted by some that steel was more susceptible to corrosion than iron. This idea may have had its origin from the fact that when steel was first produced on a large scale it was not perhaps so free from impurities as the iron of that period. Consequently, as mentioned above, it would vary more in potential and therefore its tendency to rust would be greater. Cast iron will not rust as readily as wrought iron unless the skin is removed in which case it will rust faster. As it is usually more impure chemically it is liable to have strains set up in cooling and is softer after its outside scale is removed than wrought iron all of which tend to make it rust faster than wrought iron.

While considering the ability of a specimen of iron or steel to resist corrosion, we must not lose sight of the fact that while one material or lot of a material may start to rust faster than the other, yet it may or may not in a long test show as much total corrosion as another specimen. That is to say, the material which rusted faster at first may outlive the other just as a sickly child sometimes may develop into a vigorous man and outlive some of his friends who had a better physical start than he did.

Iron will not corrode in air unless moisture is present. It has also been shown that sea water from which air and oxygen have been removed will not cause corrosion. Further, alcohol containing oxygen but no water does not effect iron to corrode it. Thus it will be seen that it is vitally important to the corrosion of iron that both oxygen and moisture be present.

This perhaps explains why surfaces of iron or steel which are alternately wet and dry corrode much faster than those which are either entirely submerged or those always in a dry place.

Experiments of recent date by Friend have shown that iron over the surface of which water was allowed to flow at a low rate of speed would rust less than if the flow was somewhat greater but if the water flowed very rapidly then corrosion was practically eliminated.

In or near large cities where much coal is burned there is always a considerable amount of sulphur dioxide present in the atmosphere. This gas when combined with moisture in the presence of soot tends to form sulphuric acid which is particularly active in attacking iron and steel as is shown by the proneness of railroad bridges to corrosion unless special attention is given to the protection of their surfaces.

Sea waters, particularly those near the mouths of rivers, in harbors, etc., have dissolved in them more or less salts, especially chlorides, with some ammonia, bromides of magnesium and iodine, nitrates, sulphates, and organic matter. All of these substances aid corrosion so it is not unreasonable to expect the large amount of rusting which usually occurs on unprotected iron or steel exposed to the action of sea water. Cast iron is acted on by sea water in a rather interesting manner as it is converted, after long exposure to sea water, into a black mass resembling graphite, sometimes so soft that it can be cut with a knife. An analysis of a sample of iron which had been exposed to the action of sea water for a considerable length of time indicated that it was composed of 41% carbon; 36% of protoxide of iron (FeO); 20% of carbon dioxide and moisture; and 3% silt or earthly matter. This change of iron into a plumbago-like substance has been attributed to the presence of carbon dioxide gas in the water.

Iron in contact with some nonmetallic materials is affected by galvanic action as will be noted when iron spikes or bolts are used in wooden ship construction or when bolts are used in holding piles together at docks, but no doubt some of this corrosion is due to direct chemical action of the organic acids of the wood.

Most impurities in iron and steel have a very considerable effect on corrosibility although some impurities such as non-metals (with the exception of sulphur) apparently protect. Those metallic substances, such as magnesium, which are present in iron and which by themselves are more easily corroded than iron, will increase the corrosion of the latter while others like zinc, nickel and chromium if properly alloyed with the iron, will help it to resist corrosive action, but if not thoroughly alloyed the foreign particles may form centers from which pitting will start and extend. Steels high in manganese are easily corroded. Carbon well combined with the iron in the steel decreases the tendency of the latter to corrosion which accounts for the fact that high carbon steel is less corrodible than mild steel or iron.

Of all the materials used to protect the surface of iron and steel from corrosion, red lead is considered the best with graphite paint a near second. The peroxide of iron, $Fe_2 O_3$, mixed with pure linseed oil as a medium, has been used extensively for painting iron work and especially iron roofs. Being the highest oxide of iron no further oxidation can take place and while as stated above, there might be galvanic action between the iron and its oxide yet the presence of the linseed oil may have a restraining effect to such action and the peroxide of iron itself acts as a barrier to the contact of oxygen of the air with the metallic iron.

The corrosibility of the steel reinforcement in concrete is a subject which deserves considerable attention because of the extensive use of concrete in the structures of today. To protect this steel reinforcement from fire and moisture it should be imbedded at least 1½ inches in the concrete. Neat Portland cement is an excellent protector of iron against corrosion and its method of operation seems to be due to the action of the free calcium hydrate in absorbing any carbonic acid gas that may enter the pores of the concrete and inhibit the effect of the gas on the iron. In order to maintain the maximum protective effect of concrete on the reinforcement steel, the concrete which is to come in contact with the steel should be sufficiently wet when cast to make a film of neat cement in close contact with all surfaces of the reinforcement. This is helped by having the concrete well tamped into place. If concrete is liable to be saturated with moisture much of the time, the protective film of neat cement next to the iron may disappear and rusting will start. For this reason concrete that is to be in use under damp conditions should be waterproofed on its surface to protect the reinforcement.

Corrosion takes place more rapidly when the iron is covered with a thin layer of water than when immersed entirely in the water, therefore, if iron is partly submerged, it will rust more rapidly at the water surface than on the portion above or below. This fact is also true for the rotting of wood, and, in using iron or wooden posts in water care should be taken to protect them from the action of the elements, particularly at the water-line.

Corrosion is much more rapid in cold water than in hot, other conditions remaining the same.

Fuller, in the "*General Electric Review*" states that he has used a quick method to indicate the corrosion resisting qualities of a steel by observing the action of a drop of water on a polished surface of the metal. Drops of distilled water at the same pressure and temperature as the air are placed on various steel surfaces and at the end of a few minutes the corrosion product will be noticed distributing itself, always according to the same pattern. Three distinct zones develop: an outer one which Fuller calls the "immune" zone; an inner one, which occupies a large part of the area of the drop; and a "wall" zone, which lies between the outer and inner zone. The outer zone is best described as a line. The iron rust will be evenly distributed over the inner zone and will be piled up to a high level on the wall zone, and the "immune" zone will be found entirely free from deposits of any kind.

The length of time elapsing before the first appearance of rust, and the amount of rust present after the drop has evaporated will vary greatly with different steels and furnishes a means of estimating the relative resistivity to corrosion of samples of steel submitted to the test.

All theories of corrosion admit that oxygen and carbon dioxide gases dissolved in water have an active relation to the process of corrosion and in recent years in both the United States and Europe apparatus has been devised to permit the oxygen in the water to act on some cheap iron scraps in a suitable container before this water enters a boiler or other expensive equipment, the idea being to remove the oxygen and carbon dioxide from the water to a large extent and thus prevent its harmful corrosion on the more expensive apparatus. An apparatus for this purpose is called a "deactivator."

In carrying out this method it has been found that if the water is heated it will attack the scraps more effectively. A good variety of iron scraps to use in "degassing" boiler water is a steel containing manganese because it corrodes more readily.

The Kestner "degasser" is a European apparatus built to carry out this process and the Speller process in the United States also works on this principle although its method of operation is somewhat different than that of the Kestner.

Another way to rid water of a large part of the gases dissolved in it is by reducing the pressure on the water and increasing its temperature. It is generally known that at the boiling point, practically all of the gases dissolved in water are expelled and if water under atmospheric pressure be heated to the boiling point, 212° F., and sprayed into a chamber under partial vacuum, the water will partially vaporize and the gases dissolved in the water will be driven out of the water and remain in gaseous form above the liquid. If these gases are then drawn off by a suitable suction pump and the water remaining be kept out of contact with air or other gases until used, it should be practically free from corrosive effect as far as dissolved gas is concerned. This type of apparatus is called a "deaerator."

These methods of pretreatment of boiler feed water seem to have been found effective in overcoming the corrosive action of the waters due to dissolved gases.

Many boiler feed waters if taken from rivers or other sources subject to pollution from industrial plants sometimes contain salts and acids which of themselves attack iron in a chemical way and consequently the harmful effects of these chemical substances must be overcome by neutralization or removal before it is altogether safe to use such waters. This sort of corrosion is apart from that caused by the action of pure natural waters which contain only dissolved gases. Sulphuric acid is frequently found in the waters adjacent to coal mines and of course it will attack iron if in sufficient quantity.

As the waters differ in the kind and amount of dissolved impurities it is evident that to overcome their corrosive qualities, different treatments will be required and there is no one general method applicable to all waters.

As corrosion is likely to occur on all exposed steel structures to some extent, engineers and designers of bridges, steel framed buildings and other structures should keep this point in mind and where possible arrange the members of such structures so that they are readily accessible for painting if they are not adequately protected from the action of gases and moisture.

Building up Shafts by Welding.

By H. J. Vander Eb

THE art of autogenous welding has gradually developed during the last decade into a very important and useful branch of engineering. While there is still considerable conflict of opinion as to the reliability of autogenous welding when applied under this, that, or the other method, the unescapable truth is that as yet no method has been advanced whereby one can definitely determine the strength of welded work short of testing it to destruction.

This statement is not intended as an indictment of autogenous welding as it is not to be denied that an enormous amount of capital has been conserved by its judicious application. It does mean that, now as never before, careful judgment must be exercised to avoid danger to human life and costly wrecks of apparatus whose failure entails consequences that are far more serious than the mere parting of the weld. Insurance companies and governmental safety bodies are therefore constrained to continue an attitude of great prudence with all attempts at welding where the safety of persons and surrounding property depends vitally on the strength of the weld.

One rather extensive use that is being made nowadays of autogenous welding is the building up of shafts to a larger diameter by fusing a certain thickness of welding material over their surface at any desired points. This may be done for restoring worn bearing surfaces to their original size or at the location of a flywheel on a shaft in case the flywheel has worn itself loose.

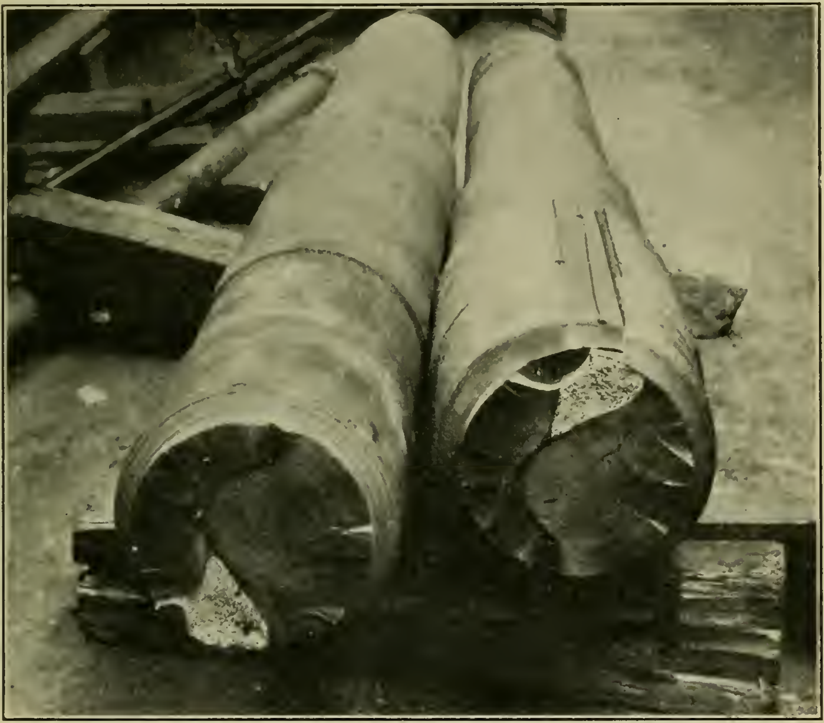
Superficially it may appear that this is an entirely harmless procedure, as of course it might be reasoned that in any event the original strength of the shaft can at least be counted on after the building up, granting that one would not want to assume that the added metal gives any added strength.

In reality however, the same element of uncertainty that is present with all welding is also introduced by this building-up process. For a number of years this fact has been known, through occasional failures of shafts and other parts which had been so treated, and subsequent reliable investigations have clearly revealed the cause. It was found that the high temperature of welding, locally applied to a body of steel, affects the physical structure of that steel, the effect being that hardening takes place. Especially is this true with massive objects such as shafts, the main body of the material absorbing the heat so fast that a quenching action results in the heated metal. The hardening is found to be localized near the surface of the shaft immediately adjacent to the added metal.

It is possible to remove hardness by thorough annealing; that is, by subjecting the object completely to a soaking heat and letting it cool off slowly. Unfortunately the average welding shop is not equipped to give this treatment nor is it sufficiently appreciated by welders how imperative is the need of annealing with this particular class of work.

It appears to be quite likely that incipient cracks are started in the surface of the metal during the welding or before the hardened zone can be annealed. This supposition is based on the fact that, in some cases of building up, serious distortion of the shaft had been observed which may be taken as an indication that high internal stresses exist. However, if no annealing is done, the likelihood of minute cracks developing in the hardened zone would seem to be practically a certainty and when once started these cracks may lead to complete failure when the usual working stresses are applied for a sufficient length of time.

The break in the shaft shown in the accompanying illustration had every earmark of being a failure of this nature. This was practically a new shaft, 10½ inches in diameter, and part of an electrically driven ammonia compressor. The armature of the motor had been used temporarily on a larger shaft and for this purpose had been bored out to a greater diameter. When it was to be replaced on its own compressor unit the shaft of this machine was built up by autogenous welding about an inch in thickness over a length of about 17 inches so as to accommodate the increased bore of the armature.



Failure of Shaft Caused by Welding.

After the shaft had run for only a few months it was observed that it had developed a considerable deflection and that at one end the built up section seemed to be loose on the shaft. This deflection varied for different positions of the shaft, causing a seriously irregular airgap between the armature and the field poles of the motor, making further service of the shaft impossible.

It was not discovered, however, until after the section of added metal was turned partly off in a lathe that this shaft was almost completely broken in two. The small light colored area in each of the fractured surfaces was the only place where the metal had remained together, this being later purposely broken off. A close examination of the fracture left no doubt that its origin was any other than that described in the foregoing and definitely excludes the possibility of a forging flaw having been responsible.

It will be noted that a keyway which was present under the welded section had been filled with a steel bar and it was clearly evident that under this keyway no hardening had taken place which probably accounts for the metal at this point remaining sound.

The process used was electric arc welding by which the additional metal was laid on in a lengthwise direction. No annealing was done. It appears that the metal of this shaft must have received particularly severe punishment during the welding as it was found to be considerably sprung out of line when the welding job was completed. It was therefore necessary to turn the shaft to a somewhat smaller diameter at the bearings in order to make these bearing ends again concentric with the central portion of the shaft.

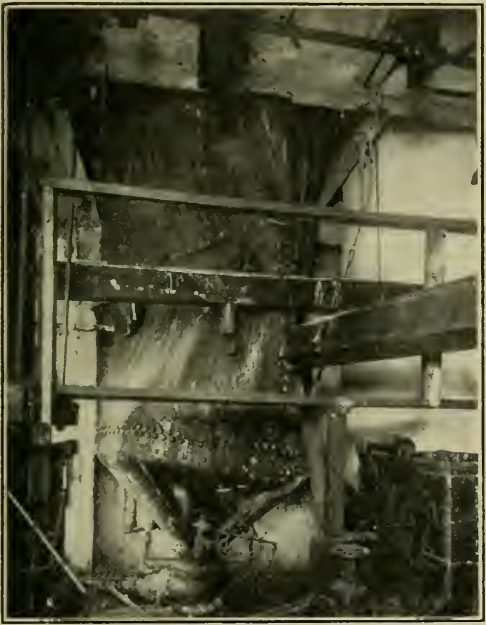
A fortunate feature of the case was that this shaft was required to run at a rather slow speed so that it was possible to detect the abnormal deflection in time and thus a costly wreck was avoided.

While it is not usual to build up a shaft as much as 1 inch, as was done with this shaft, the element of risk appears to be essentially alike, whether one builds up 1 inch or ¼ inch in thickness. This failure may therefore well serve as an example and warning to manufacturers of high speed machinery such as, for example, steam turbines. This type of apparatus appears particularly prone to running to complete destruction in case of shaft failure and under such circumstances seriously endangers life and surrounding property. Therefore, in view of the uncertainty above referred to, it would appear particularly advisable not to take any chances with welding since a very low percentage of failures of turbine shafts entails so much destruction as to make it a poor investment in the long run.

An Unusual Accident to a Cooking Tank.

A RATHER unusual demonstration of the pressure of the atmosphere and the damage it can cause was illustrated by an accident which happened recently to a closed vertical cooking tank in which the offal from animals slaughtered in a packing plant was boiled up to obtain soap stock and fertilizer materials.

It seems that after emptying the tank, it was filled by steam and all valves closed and the condensation of this steam caused a partial vacuum that allowed the pressure of the atmosphere to exert its power on the outside of the tank shell. While theoretically a cylindrical shell ought to keep its shape when subjected to a uniform outside pressure, in actual practice, pressure on the outside surface of a cylindrical shell is almost sure to cause the failure of the same by collapse unless special bracing is provided to keep the shell in shape. A vacuum of 27 to 28 inches of mercury might be expected under the conditions outlined above and this would allow an atmospheric pressure of 13½ to 14 lbs. per square inch of area to be exerted on the outside of the shell. While it would have been safe to use three times this pressure inside the tank, it is quite evident that the tank could not stand up under atmospheric pressure on the outside without the support of some pressure inside and therefore the shell caved in at three points. The shell was so badly distorted and it had been in service for so long, that it was considered desirable to replace the tank with a new one. As this accident was due to external rather than internal pressure, the damage was not covered by the explosion insurance policy carried on the tank.



A Collapsed Cooking Tank.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, EDITOR. C. L. WRIGHT, ASSISTANT EDITOR.

HARTFORD, JANUARY, 1923.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

ECONOMICS has been defined by many writers as the science of wealth. Of the latter term, wealth, a prominent authority on economics has said that it includes " those things which men want, which are not free, and which present the problems of effort, of satisfaction through effort, of the organization of industry."

A manufacturer in purchasing an engine for his plant gives dollars — which are merely a medium of exchange — for a tangible piece of wealth. However, when that same engine is installed and is operating the plant it acquires additional value. Although in the abstract it represents no greater a portion of wealth than it did previous to being placed on its foundation yet, may we ask, would the owner now accept for it, subject to the machine's instant removal, the same number of dollars that he gave? Certainly not, for now that engine is a part of a greater machine, a manufacturing process, and if suddenly taken away the loss in wealth may be, indeed will be, many times that of the engine. No, we feel sure, the owner would not sell under any such terms.

Fate, however, is a customer with whom we all must deal and Fate does not wait for any convenient time of delivery. Instead she steps in and makes her demands upon wealth " at sight." Almost in the twinkling of an eye she may make a complete wreck of a valuable engine.

Insurance is a means to compensate for the losses brought about by the demands of Fate.

Personal.

It is with great regret that we have to announce that our Auditor, Mr. Frank M. Fitch, has decided to sever his connections with this Company on January 10th, 1923, to establish a private business of his own. We are sure all of the Hartford force will join in this regret and that not alone the Home Office but our Branch Offices also will miss him and the pleasure of his frequent business visits.

Mr. Fitch entered the employ of THE HARTFORD in its Underwriting Department in February 1901. Previously he had held the office of auditor and actuary for the Hartford Life Insurance Company and when in 1905 it was found desirable to reorganize the accounting system of our rapidly-growing Company, this experience and his broad knowledge of accounting methods naturally led to his election to the new position of auditor which was then created. He has continued to serve the Company in that position for nearly twenty years. During this period he has, as we all know, devised an accounting system to correctly and conveniently record the financial statistics of our business, developing and improving it as the exigencies of changed conditions demanded. This system is so adapted to checks and counter-checks that it is readily audited, but Mr. Fitch also has made it an important part of his duties to periodically visit each department and branch office to personally examine the accounts and records in them. These visits have served to make him as well known in the outlying districts as perhaps any of the Home Office officials.

Mr. Fitch has always had a fondness for analyzing and studying investments, and during the last six years his ability and knowledge in these lines has been given opportunity, for since 1916, although his title remained unchanged, he has been actively assisting the treasurer and other officers in the purchase of securities and in other financial matters.

We are all sorry that Mr. Fitch has found attractions elsewhere to take him from us. We hope they will prove as greatly to his interest as he anticipates, and we assure him that with him goes the warm regard of the HARTFORD organization and our best wishes for his future.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF DECEMBER, 1921 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
564	10	Section of heating boiler cracked			Rev. M. J. Gallagher	School	Wyandotte, Mich.
565	10	Firebox sheet cracked and staybolts loosened			Hartburg Lumber Co.	Lumber	Hartburg, Texas
566	10	Boiler exploded	1	1	Tanker "Comet"	Oil Tank Ship	Providence, R. I.
567	10	Boiler flue exploded		4	B & S Mine Shaft No. 1	Coal Mine	Brockwayville, Pa.
568	11	Three sections of heating boiler cracked			Holy Family School	School	Denver, Colo.
569	12	Boiler exploded		1	Empire Mfg. Co.		Goldsboro, N. C.
570	12	Bleaching Kier exploded			W. O. Davey & Sons	Oakum Plant	Jersey City, N. J.
571	12	Boiler exploded			Victory Mine	Mine	Chicopee, Kan.
572	12	Boiler exploded			Winnette Elec. Light Co.	Electric Plant	Winnette, Mont.
573	12	Fire sheet bulged and ruptured			Howe School	School	Howe, Ind.
574	13	Nipple between manifold and section pulled out			Rev. Dennis J. Dougherty	Church	Philadelphia, Pa.
575	15	Section of heating boiler cracked			Town of Ludlow, Mass.	School	Ludlow, Mass.
576	15	Section of heating boiler cracked			Boro School District	School	Beaver Falls, Pa.
577	15	Boiler sheets bagged and ruptured			Southern Clay Mfg. Co.	Brick Mfgrs.	Lewisburg, Ala.
578	15	Section of heating boiler cracked			Board of Education	School	Eureka, Ill.
579	15	Section of heating boiler cracked			Dillard & Yerger	Office Bldg.	Memphis, Tenn.
580	15	Section of heating boiler cracked			Gluck Bros.	Chair Mfgrs.	Brooklyn, N. Y.
581	15	Section of heating boiler cracked			H. W. Riddle	Apmt. House	Ravenna, Ohio
582	15	Stove water back exploded		1	George Hudson	Residence	Holley, N. Y.
583	15	Three sections of heating boiler cracked			Michigan State Sanatorium	Nurses Home	Howell, Mich.
584	16	Locomotive exploded	3	1	Santa Fe R. R. Co.	Railroad	Standish, Mo.
585	16	Boiler tube ruptured			Michigan Sugar Co.	Sugar Mfgrs.	Carrolton, Mich.
586	16	Six sections of heating boiler cracked			Isaac Richmond		Springfield, Mass.
587	17	Boiler of locomotive exploded		6	Norfolk & Western R. R.	Railroad	Williamson, W.Va.
588	17	Digester cracked			S. D. Warren Co.	Paper Mill	Yarm'thville, Me.
589	18	Section of heating boiler cracked			Lipman-Schnurmacker	Garage	New York, N. Y.

590	19	Boiler exploded			Contractors' Road Oiling Co.	Oil Heating Plant	Alameda, Cal.
591	19	Boiler exploded		1	Hodge Gravel Pit	Gravel Pit	East Auburn, Ind.
592	19	Pipe fitting in steam line failed			American Printing Co.	Cotton Mills	Fall River, Mass.
593	20	Section of heating boiler cracked			Joseph & John L. Bonee	Apmt. House	Hartford, Conn.
594	20	Heating boiler exploded			Lafayette Hotel	Hotel	New Orleans, La.
595	21	Section of heating boiler cracked			Meserole Exhibition Co.	Theater	Brooklyn, N. Y.
596	21	Boiler tubes exploded			Municipal Electric Plant	Elec. Power Plant	Martins Ferry, O.
597	21	Rendering tank exploded		1	Anderson Fertilizer Co.	Fertilizer Plant	Anderson, Ind.
598	21	Two sections of heating boiler cracked			Superior Garage	Garage	Brooklyn, N. Y.
599	22	Two sections of heating boiler cracked			The Stanley Co. of America	Theater	Philadelphia, Pa.
600	22	Stove water front and range boiler exploded		1	Wm. G. Underwood	Residence	Harrisburg, Pa.
601	22	Boiler exploded		2	Gulf Production Co.	Oil Well	Orange, Texas
602	23	Section of heating boiler cracked			The Stanley Co. of America	Theater	Philadelphia, Pa.
603	23	Section of heating boiler cracked			Board of Education	School	TraverseCityMich.
604	23	Section of heating boiler cracked			Independent School District	School	Denison, Ia.
605	23	Boiler sheet ruptured			Swift & Co.	Packing Plant	Milwaukee, Wis.
606	24	Two sections of heating boiler cracked			The Borg & Beck Co.	Machine Shop	Moline, Ill.
607	25	Two sections of heating boiler cracked			Estate of Albert Van Voast	Bank & T'ter Bldg.	Schenectady, N. Y.
608	26	Nozzle cracked			Federal Light & Traction Co.	Elec. Lgt. & P'wer	Springfield, Mo.
609	26	Shell plate bulged and ruptured			Bay City Packing Co.	Oyster Packing	Apalachicola, Fla.
610	27	Section of heating boiler cracked			Wichita Consistory No. 2	Masonic Temple	Wichita, Kan.
611	27	Boiler tube ruptured			Atlantic Steel Co.	Steel & Wire Wks.	Atlanta, Ga.
612	28	Two sections of heating boiler cracked			John J. Ryan Shoe Co.	Shoe Mfg.	Peabody, Mass.
613	28	Air tank exploded			Fred T. Ley & Co.	Contractors	Miami, Fla.
614	29	Boiler exploded		3	Desenberg Well	Oil Well	Corsicana, Texas
615	29	Heating boiler exploded			Charles W. Fowler	Residence	Elizabeth, N. J.
616	29	Boiler sheet bulged			Morris-Howard Lumber Co.	Saw Mill	Camden, Ala.
617	30	Tube ruptured			Weirton Steel Co.	Steel Mills	Weirton, W. Va.
618	30	Pipe fitting in blow off line failed			Columbia Mills		Saginaw, Mich.
619	31	Four sections of heating boiler cracked			The Chase Co.	Metal Works	Waterville, Conn.
620	31	Crown sheet failed			Edw. Hines Yellow Pine, Trustees	Lumber	Kiln, Miss.

MONTH OF JANUARY, 1922

1	1	Section of heating boiler cracked			Woodberry Forest School, Inc.	Boarding School	Woodb'y For., Va.
2	1	Three sections of heating boiler cracked			H. Reich & C. Herman	Theater	New York, N. Y.
3	1	Header cracked			The Farnsworth Pinney Co.	Woolen Mills	Central Vil., Conn.

MONTH OF JANUARY, 1922 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
4	2	Boiler exploded			American Lacquer Co.	Lacquer Plant	Bridgeport, Conn.
5	2	Tube pulled out of tube sheet			Columbia Mills, Inc.		West Pullman, Ill.
6	3	Section of heating boiler cracked			Borough of Wilkinsburg	Public School	Wilkinsburg, Pa.
7	3	Front header cracked			Utah-Idaho Sugar Co.	Sugar Mfg.	Garland, Utah
8	3	Two sections heating boiler cracked		1	Najeb Hayeck	Stores & Offices	Lowell, Mass.
9	3	Top of automatic stop valve failed			City of Falls City	Elec. Power Plant	Falls City, Neb.
10	4	Boiler exploded			Hudson Valley Power Co.	Power Plant	Stillwater, N. Y.
11	4	Hot water tank exploded	1	1	W. C. McAbee	Residence	Greenville, S. C.
12	4	Air tank exploded	1		Dixie Sales Co.	Garage	Greensboro, N. C.
13	4	Three sections of heating boiler cracked			M. P. Corset Co.	Corset Factory	Derby, Conn.
14	4	Two sections, three headers and one elbow cracked			John S. Nicholas		New York, N. Y.
15	5	Rear section of heating boiler cracked			I. Ginsberg Sons, Inc.	Factory & Store	Glens Falls, N. Y.
16	6	Six sections of heating boiler cracked			Lackawanna Bridge Works	Struct'l Steel Plt.	Buffalo, N. Y.
17	6	Section of heating boiler cracked			Exchange Bldg. Co.	Office Bldg.	Little Rock, Ark.
18	6	Four sections of heating boiler cracked			Jacques Kahn Realty Co.		New York, N. Y.
19	6	Blow off pipe ruptured			Liberty School	School	Highl'd P'k, Mich.
20	7	Two sections of heating boiler cracked			Mayer & Schneider	Theater	New York, N. Y.
21	7	Section of heating boiler cracked			John Hynes	Apmt. House	Davenport, Ia.
22	8	Two tubes ruptured			American Gas & Elec. Co.	Elec. Power Plant	Muncie, Ind.
23	8	Two sections of heating boiler cracked			Charles B. Barnes	Apmt. House	Allston, Mass.
24	8	Section of heating boiler cracked			Braddon Amusement Corp.	Theater	New York, N. Y.
25	8	Three sections of heating boiler cracked			Stanley Co. of America	Theater & Hotel	Philadelphia, Pa.
26	8	Mud drum failed			Halliday Elevator Co.	Elevator Factory	Cairo, Ill.
27	9	Tube loosened at header		1	University of Richmond	College	Richmond, Va.
28	10	Tube of locomotive ruptured			Pennsylvania R. R.	Railroad	Conemaugh, Pa.
29	10	Boiler exploded	2		Hammond Flouring Mills	Flour Mill	Fostoria, O.
30	10	Tube of H R T boiler collapsed			Beaumont Shipbuilding & Dry Dock Co.	Dry Dock	Beaumont, Texas
31	11	Heating boiler exploded				Apmt. House	Chester, Pa.
32	11	Hot water heating boiler exploded			Mrs. F. B. Scranton	Apmt. House	San Francisco, Cal.
33	11	Section of heating boiler cracked			Frank Ruffalo	Apmt. House	Kansas City Mo.
34	11	Tube pulled out of front drum			St. Paul & Tacoma Lumber Co.	Lumber	Tacoma, Wash.

35	11	Boiler exploded			Tillanook County Creamery Assn.	Cheese Factory	Tillanook, Ore.
36	12	Boiler exploded	1	4	Louis Rogers	Saw Mill	Camden, Ark.
37	12	Seven sections of heating boiler cracked			Twenty Morningside Ave. Corp.	Apmt. House	New York, N. Y.
38	12	Section of heating boiler cracked			C. B. Miller	Office Bldg.	Columbus, Mo.
39	13	Section of heating boiler cracked			Board of Public Education	School	Pittsburgh, Pa.
40	13	Sections of heating boiler cracked			Western Printing & Litho. Co.	Printing	Racine, Wis.
41	13	Pipe fitting of heating system failed			F. B. Fornwald Co.	Garage	Washington, Ind.
42	14	Boiler exploded	5	3	George Parsons	Saw Mill	Mt. Pleasant, Tex.
43	14	Heating boiler exploded			United Brethren Church	Church	Mt. Wolf, Pa.
44	15	Fire sheet ruptured			Mrs. C. L. Forster	Undertaking	Kansas City, Mo.
45	15	Four sections heating boiler cracked			Snead & Co.	Iron Works	Jersey City, N. J.
46	15	Four sections of heating boiler cracked			Bennett Kanter	Store & Dwelling	New York, N. Y.
47	15	Section of heating boiler cracked			Augusta C. Johnson	Apmt. House	Denver, Colo.
48	16	Valve on steam line exploded	1	2	Jones & Laughlin Steel Co.	Steel Mill	Soho, Pa.
49	16	Digester exploded	2	1	William F. Mosser	Tan Extract Plant	Richmond, W. Va.
50	16	Three sections of heating boiler cracked			Leonard Realty Co.	Apmt. House	New York, N. Y.
51	17	Boiler exploded	1		Andrew O. Neilson	Saw Mill	Manila, Utah
52	17	Waterback of kitchen range exploded		2	P. S. McGee	Residence	Roaring Spr'g, Pa.
53	17	Front sheet bulged and ruptured			Pintsch Compressing Co.	Gas Compressing	El Paso, Texas
54	18	Boiler exploded			Three Rivers Cheese Factory	Cheese Factory	Hebo, Ore.
55	18	Section of heating boiler cracked			City of Clarksdale	School	Clarksdale, Miss.
56	18	Two sections of heating boiler cracked			Vonhof Hotel	Hotel	Mansfield, O.
57	19	Boiler tube exploded		3		Machine Shop	Elizabethp't, N. J.
58	19	Section of heating boiler cracked			Central Metal Products Co.	Metal Products	Canton, O.
59	20	Section of heating boiler cracked			Argonne Hotel Co.	Hotel	St. Louis, Mo.
60	20	Manhole flange failed			Coca Cola Bottling Co.	Bottling Works	Terre Haute, Ind.
61	20	Four sections of heating boiler cracked			Walton & Macke Nail Co.	Nail Factory	Kokomo, Ind.
62	21	Heating boiler exploded		6		Apmt. House	San Francisco, Cal.
63	21	Heating boiler exploded			Dupont Camp Lewis	Schoolhouse	Camp Lewis, Wash.
64	21	Four sections of heating boiler exploded			School Board	High School	Sacramento, Cal.
65	21	Boiler exploded			Silver Lake Creamery	Creamery	Silver Lake, Ore.
66	21	Heating boiler exploded			Sapulpa City Hospital	Hospital	Sapulpa, Okla.
67	21	Twelve staybolts of rear head pulled out			Susquehanna Collieries Co.	Mine	Lykens, Pa.
68	22	Header of W. T. boiler ruptured			Amicable Life Ins. Co.	Office Bldg.	Waco, Texas
69	22	Boiler exploded		2		Oil Well	Haynesville, La.
70	23	Tube ruptured	1		Dow Power House	Power Plant	Midland, Mich.
71	23	Section of heating boiler cracked			Isaac Honicker	Business Block	Lorain, O.
72	23	Section of heating boiler cracked			Holyoke Supply Co.	Steam Sup's. Mfy.	Holyoke, Mass.
73	23	Section of heating boiler cracked			H. Reich & C. Herman	Theater	New York, N. Y.

MONTH OF JANUARY, 1922 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
74	24	Heating boiler exploded			Matty Hersee State Charity Hospital	Hospital	Meridian, Miss.
75	24	Feed pipe pulled away from rear head			Cummer Mfg. Co.	Grate Mfy.	Cadillac, Mich.
76	24	Tube pulled out of front header			University of Richmond	Hospital	Richmond, Va.
77	24	Two sections of heating boiler cracked			S. O. Hoyt	Public Hall	Holyoke, Mass.
78	24	Section of heating boiler cracked			Simmons Boot & Shoe Co.	Store	Toledo, O.
79	24	Two tubes cracked			Sisters of Charity of Cincinnati	Hospital	Cincinnati, O.
80	24	Tube ruptured		1	United States Gypsum Co.	Mine	Oakfield, N. Y.
81	24	Section of heating boiler cracked			Board of Education	School	Newton, Kan.
82	25	Blow off pipe ruptured		1	United States Shipping Board	Ship Yard	Philadelphia, Pa.
83	25	Pipe fitting in steam line failed			American Printing Co.	Cotton Mills	Fall River, Mass.
84	25	Section of heating boiler cracked			Utica City National Bank	Office Bldg.	Utica, N. Y.
85	25	All sections of heating boiler cracked			Congregation Beth Hanedrosh	Synagogue	Brooklyn, N. Y.
86	25	Pipe fitting of heating system failed			F. B. Fornwald Co.	Garage	Washington, Ind.
87	25	Heating boiler exploded			Jones Garage	Garage	Tuscola, Ill.
88	25	Heating boiler exploded		1	Ernest J. Cummings	Grocery Store	Lynn, Mass.
89	25	Water heater exploded			Dr. Geo. C. Hafford	Residence	Albion, Mich.
90	26	Three sections of heating boiler cracked			Molton Hotel Co.	Hotel	Birmingham, Ala.
91	26	Tube ruptured		1	American Reduction Co.	Reduction Plant	Pittsburgh, Pa.
92	26	Header cracked		6	Barrett Co.	Roofing Materials	Elizabeth, N. J.
93	27	Boiler explosion	1	0	Sinclair Lease	Oil Well	Kaw City, Okla.
94	27	Boiler explosion			Curtis Publishing Co.	Publishers	Detroit, Mich.
95	27	Boiler explosion	1		Tyler Warehouse Co.	Warehouse	St. Louis, Mo.
96	27	Section of heating boiler cracked			Independent School District	School	Oelwein, Ia.
97	27	Tube ruptured			Sperry Flour Co.	Flour Mill	Tacoma, Wash.
98	27	Three sections of heating boiler cracked			Consolidated School District	School	New B'tain, Conn.
99	27	Header failed		1	Eddystone Steel Co.	Steel Mill	Eddystone, Pa.
100	28	Boiler of locomotive exploded	2		Seaboard Air Line R. R. Co.	Railroad	Dinwiddie, Va.
101	28	Boiler exploded		2	Knox Building	Clothes Pres. Plt.	Thomson, Ga.
102	28	Three sections of heating boiler cracked			Schaf Holding Co.	Theater	New York, N. Y.
103	29	Tube ruptured			Oval Wood Dish Co.	Woodenware	Tupper Lake, N.Y.
104	29	Header fractured			Pittsburgh Plate Glass Co.	Glass Factory	Chrystal City, Mo.
105	29	Section of heating boiler cracked			Estate of Roy Cubbage	Business Block	Des Moines, Ia.

106	29	Boiler bagged and ruptured			Arcadia Mills	Cotton Mills	Spartansb'g, S. C.
107	29	Two sections of heating boiler burned through			General Motors Corp.	Automobile Fact'y.	Buffalo, N. Y.
108	30	Boiler exploded		1	Hogshire Bldg.		Newp't News, Va.
109	30	Six sections of heating boiler cracked			World Realty Co.	Theater	Omaha, Neb.
110	30	Tube failed		1	Virginia Caroline Chemical Co.	Power Plant	Charleston, S. C.
111	30	Tube ruptured			Rex Paper Co.	Paper Mill	Kalamazoo, Mich.
112	31	Blow off pipe failed			Mogadore Insulator Co.	Insulators	Mogadore, O.
113	31	Header cracked			Agasta Mill Board Co.	Paper Board Mill	Trenton, N. J.
114	31	Heating boiler exploded			Charles A. Allen	Residence	Hooperstown, Ill.
115	31	Boiler exploded			Silver Lake Creamery	Creamery	Silver Lake, Ore.
116	31	Four sections of heating boiler cracked			School Trustees	School	Pontiac, Ill.

MONTH OF FEBRUARY, 1922

117	1	Boiler exploded			State House		Boston, Mass.
118	1	Blow-off pipe failed			Boonville Mills Co.	Flour Mills	Boonville, Mo.
119	1	Section of heating boiler cracked			The New Era Printing Co.	Printing	Lancaster, Pa.
120	2	Boiler exploded			Bancroft School	School	Omaha, Neb.
121	2	Heating boiler exploded			William May	Residence	Springfield, Mass.
122	2	Blow-off pipe broken by settling of boiler			Centralia Gas & Elec. Co.	Power Plant	Centralia, Ill.
123	3	Vulcanizer exploded			Joplin Tire Service Co.	Vulcanizing Plt.	Joplin, Mo.
124	3	Section of heating boiler cracked			School District No. 1	School	Butte, Mont.
125	4	Two sections of heating boiler cracked			Board of Education	School	Canton, Ohio
126	4	Section of heating boiler cracked			The Garwood Co.	Manufacturing	Garwood, N. J.
127	4	Tube of H. T. boiler collapsed			G. E. Miller	Saw Mill	Hartsville, S. C.
128	5	Section and manifold of heating boiler cracked			Hicks Bldg.	Office & Store Blg.	San Antonio, Tex.
129	6	Tube failed		2	Meriden Electric Light Co.	Elec. Lght. Plant	Meriden, Conn.
130	6	Two sections of heating boiler cracked			Congregation B'Nai Jehudah	Church	Kansas City, Mo.
131	7	Three sections of heating boiler cracked			Michael Manos	Theater	Greenburg, Pa.
132	7	Girth seam leaked			Federal Shipbuilding Corp.	Ship Building	Kearney, N. J.
133	8	Boiler exploded	2	1	W. E. Waller	Planing Mill	Stedman, S. C.
134	8	Boiler exploded		1	Rossi Bros.	Nursery	Berkeley, Cal.
135	9	Temporary wooden manhead burst			J. A. Husky	Saw Mill	Blevin, Ark.
136	9	Section of heating boiler cracked			Swedish Evangelical Mission Congregational Church	Church	Bridgeport, Conn.

MONTH OF FEBRUARY, 1922 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
137	9	Blow off failed		1	Birge Forbes Co.	Oil Mill	Sherman, Tex.
138	9	Boiler exploded		1	McLean Fire Brick Co.	Fire Brick Plant	E. Liverpool, O.
139	10	Boiler exploded	1	2	George A. Rutherford	Woodworking	Cleveland, Ohio
140	10	Safety valve blown off			France Co.	Stone Works	Bellevue, Ohio
141	10	4″ pipe on boiler failed			Davidson Rubber Co.	Hard Rubber Mfy.	Charlest'n, Mass.
142	11	Boiler exploded				Residence	Brooklyn, N. Y.
143	12	Five headers broken			United Engineering & Foundry Co.		Pittsburgh, Pa.
144	12	Section of heating boiler cracked			St. John's Church	Church	N'thampton, Mass.
145	13	Boiler exploded	2	1		Saw Mill	Gaston, S. C.
146	13	Boiler exploded		1	Woolf's Furniture House	Store	Chicago, Ill.
147	13	Manifold of heating boiler cracked			C. B. & A. J. Stevens	Greenhouses	Shenandoah, Ia.
148	13	Tube ruptured			Texas Co.	Oil Refinery	Norfolk, Va.
119	14	Hot water heater exploded		2	Boston University	College	Boston, Mass.
150	14	Boiler exploded			Catholic Sokol Hall	Assembly Hall	Omaha, Neb.
151	14	Rear shell plate of boiler bagged and ruptured			Collwood Lumber Co.	Lumber Mill	White City, Tex.
152	15	Section of heating boiler cracked			Estate of Eloise L. Norris	Residence	New York City
153	15	Rear bottom plate of boiler bulged			Standard Parts Co.	Auto Parts Mfy.	Canton, Ohio
154	15	Header of boiler cracked			Colonial Trust Co.	Bank Bldg.	Pittsburgh, Pa.
155	15	Section of heating boiler cracked			School District No. 32	School	Tecumseh, Neb.
156	15	Fourteen cast iron tubes of heating boiler cracked			Louis A. Solomon	Apartments	New York City
157	15	Two sections of heating boiler cracked and fusible plug melted			Wesson Memorial Hospital	Hospital	Springfield, Mass.
158	15	Five sections of heating boiler cracked			Vonhof Hotel	Hotel	Mansfield, Ohio
159	16	Six sections of heating boiler cracked			Edgar L. Ropkins	Stores	Hartford, Conn.
160	16	Four sections of heating boiler cracked			Church of Our Lady of Mercy	Church	New York, N. Y.
161	17	Section of heating boiler cracked			Seventh St. Garage Co.	Garage	Richmond, Va.
162	17	Two sections of heating boiler cracked			Joseph H. Stern	Hotel	Indiana, Pa.
163	17	Two sections of heating boiler cracked			Augusta C. Johnson	Apartments	Denver, Colo.
164	17	Eight front headers cracked			Alexander Smith & Sons	Carpet Mills	Yonkers, N. Y.
165	19	Water tank exploded			Anderson Pure Food Bakery	Bakery	Anderson, Ga.
166	20	Rear section of heating boiler cracked			Central Metal Products Co.	Metal Works	Canton, Ohio

167	23	Rear header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
168	23	Section of heating boiler cracked			Harry B. Willson	Apartments	Washington, D. C.
169	24	Head of air receiver cracked			The France Co.	Stone Works	Huntington, Ind.
170	24	Plates burned as result of low water			Board of Education	School	Fort Worth, Tex.
171	26	Section of heating boiler cracked			Board of Public Education	School	Pittsburgh, Pa.
172	29	Tube ruptured			United States Gypsum Co.	Gypsum Plant	Chicago, Ill.
173	28	Vulcanizer boiler exploded			Oil City Vulcanizing Co.	Vulcanizing Plt.	Franklin, Pa.
174	28	Hot water boiler exploded			Stiller Bros.	Restaurant	Canton, Ohio
175	28	Section of heating boiler cracked			City of Clarksdale Corp'n.	School	Clarksdale, Miss.
176	28	Tubes pulled from drum of power boiler			Alton Box Board & Paper Co.	Paper Mill	Federal, Ill.

MONTH OF MARCH, 1922

177	1	Seventeen headers cracked and several tubes warped			Diamond Alkali Co.	Alkali Works	Pittsburgh, Pa.
178	1	Section of heating boiler cracked			A. S. Kreider Co.	Shoe Salesroom	St. Louis, Mo.
179	1	Water tank exploded			City of Lawton	Water Works	Lawton, Mich.
180	1	Boiler exploded			Morgett Produce Co.	Store	Paris, Mo.
181	1	Boiler exploded		4	Gilberton Colliery	Coal Mine	Mahanoy City, Pa.
182	2	Three sections of heating boiler cracked			Commissioners of Beaver County	Court House	Beaver, Pa.
183	2	Section of heating boiler cracked			Board of Education	School	Chickasha, Okla.
184	2	Section of heating boiler cracked			Washer Bros. Co.	Store	San Antonio, Tex.
185	3	Rear section of heating boiler cracked			Board of Education	School	Piqua, O.
186	3	Crown sheet failed			Heldenfels Bros.	Shipyards	Rockport, Tex.
187	3	Rear header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
188	3	Tube ruptured			Monsanto Chemical Works	Acid Plant	E. St. Louis, Ill.
189	3	Main stop valve burst		2	F. M. Schildwachter	Ice Mfy.	New York, N. Y.
190	4	Two sections of heating boiler cracked			Paul M. Ellenburg	Apmt. House	St. Louis Mo.
191	4	Five sections of heating boiler cracked			National Deposit Bank	Bank	Owensboro, Ky.
192	4	Mud drum cracked			Pittsburgh Plate Glass Co.	Glass Factory	Chrystal City, Mo.
193	4	Tube ruptured			Central Products Co.	Auto Factory	Detroit, Mich.
194	4	Boiler settled and ruptured steam pipe			Wm. McMillan & Sons		Peerless, Ind.
195	4	Header of power boiler cracked			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.
196	4	Furnace sheet of power boiler bagged			City of Providence		Providence, Ky.
197	4	Three sections of heating boiler cracked			Worcester Baking Co.	Bakery	Worcester, Mass.
198	4	Mud drum plug blew out	1		Ripley Ferryboat	Ferryboat	Ripley, O.
199	5	Kitchen range boiler exploded			Edward Steinert	Residence	Lawrence, Mass.
200	5	Air compressor exploded			Standard Oil Service Sta.	Gasoline Station	Richmond, Cal.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1922

Capital Stock, . . . $2,000,000.00

ASSETS

Cash in offices and banks	$492,329.45
Real Estate	150,000.00
Mortgage and collateral loans	1,673,850.00
Bonds and stocks	6,429,307.52
Premiums in course of collection	766,619.61
Interest Accrued	120,981.61
Total Assets	$9,633,088.19

LIABILITIES

Reserve for unearned premiums		$4,602,639.11
Reserve for losses		213,814.87
Reserve for taxes and other contingencies		396,621.24
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,420,012.97	
Surplus to Policy-holders		**$4,420,012.97**
Total liabilities		$9,633,088.19

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President and General Counsel.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.

BOARD OF DIRECTORS

ATWOOD COLLINS, President, Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Bank, Hartford, Conn.
MORGAN B. BRAINARD, Vice-Pres. and Treasurer, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Ass't Treas., Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.
SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, Vice-President, Hartford Electric Light Co., Hartford, Conn.

Incorporated 1861. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLYWHEEL EXPLOSIONS AND ENGINE BREAKAGE

Department	Representatives
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, MD., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, Ct., 405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. E. Mason Parry, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'l'v'd	J. F. Criswell, Manager. P. M. Murray, Ass't Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	A. Paul Graham, Manager. L. T. Gregg, Chief Inspector.
DENVER Colo., 916-918 Gas & Electric Bldg.	J. H. Chesnutt, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, General Agent. E. Mason Parry, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnett, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickham, Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrott Bldg.	Geo. S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	McCargar, Bates & Lively, Gen'l Agents. C. B. Paddock, Chief Inspector.
SEATTLE, Wash., 540 New York Block	C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann, & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, President. The Boiler Inspection and Insurance Company of Canada.

Are Your Engines Insured Against Breakdown?

ENGINE BREAKDOWN may result in HEAVY LOSSES from:—

DIRECT DAMAGE to Property or Injury to Persons;

CONSEQUENTIAL DAMAGE to Materials, Spoiled or Injured by the Stoppage of the Power Plant;

USE AND OCCUPANCY—that is, Loss from the Inability to Occupy the Damaged Premises or to Use the Machinery Stopped by the Sudden Breakdown.

Engine Insurance Policies now offered by "*The Hartford*" will indemnify you against such losses.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER INSPECTION and INSURANCE CO.

HARTFORD CONNECTICUT

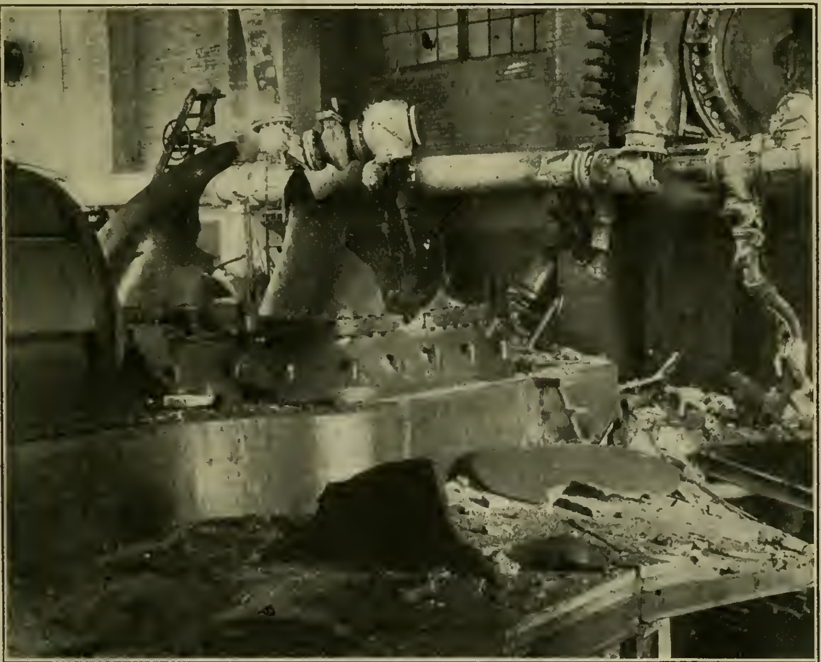
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIV. HARTFORD, CONN., APRIL, 1923. No. 6.

COPYRIGHT, 1923, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



STEAM TURBINE EXPLOSION AT INDIANAPOLIS, IND.

THERE IS VALUABLE INFORMATION FOR YOUR ENGINEER IN THIS MAGAZINE. PLEASE LET HIM SEE IT.

NOTE — The caption at the top of page 162 should read "Explosion of a Ten Thousand Kilowatt Turbine" and a similar correction should be made in the parenthesis on the fifth line of the same page.

Explosion of a One Thousand Kilowatt Turbine.

WHAT may prove to be the most serious turbine accident on record, from the standpoint of the amount of property damage, occurred at the Mill Street plant of the Indianapolis Light and Heat Company, Indianapolis, Ind., on April 2nd of this year when a 12,500 k. v. a. (approximately 1000 k. w.) turbine suddenly exploded. Information regarding the accident is as yet somewhat meagre, such as we have being obtained from the first newspaper accounts.

The accident took place about 5.30 A. M. just before a shift of operating crews. The turbine was directly connected to a generator and both machines were wrecked, the turbine most completely, as will be seen from the illustration on the front cover. The casing of the turbine was violently disrupted, parts being thrown to all parts of the building, striking and more or less seriously injuring other machines. One section weighing five tons was hurled about twenty feet in the air and landed on a large steam pipe. Another part of the machine was thrown the length of the turbine room and crashed through a window. The rotor of the turbine jumped out of its bearings and fell through an opening to the floor below, a distance of about twenty-five feet. The rotor of the generator was thrown bodily clear of the stator, or non-revolving part, seriously damaging the electrical end of the unit.

It would appear that the accident resulted from overspeeding although just how this condition was brought about is not clear. From what we can learn through newspaper reports the initial failure was of the rotor which burst from excessive centrifugal force. The combined action of the flying pieces of the rotor and the steam pressure in the casing then completed the widespread destruction.

The accident deprived a large part of the city of its supply of light and power for a considerable length of time, and the property damage was estimated as running from $700,000 to $1,000,000. It is remarkable that only two men were hurt and their injuries were not serious. It is stated that the loss was not covered by insurance.

The Importance of Fillets in Engine Shafts and Crankpins.

By E. Mason Parry
Chief Inspector, Hartford Department

One of the underlying causes of many engine breakdowns is the absence of properly formed fillets on shafts, crank pins, and other parts subject to torsion or bending stresses, where there is a change from a larger to a smaller diameter of the parts. If a fillet is not provided where these two different sized sections join, the whole member is weakened to an unnecessary degree. This requirement is not so well appreciated by designers and engineers as it should be and the object of this article is to bring the importance of fillets to the attention of not only designers of steam engines, but also to others who are responsible for the planning or repairing of machinery in which power is transferred from parts or sections of one cross sectional area to parts or sections of a greater or less area.

A case recently investigated by the writer was that of a broken shaft 9 inches in diameter in bearings and turned down to 6 inches diameter at one end for a length of 7½ inches. On this reduced section there was keyed a cast iron coupling to which was secured, by a number of bolts, a companion coupling which was keyed onto a 6 inch shaft of considerable length, used for transmitting power by means of a number of belt pulleys. The engine referred to is rated at 250 h. p. and was said to be developing 275 h. p. at the time the shaft broke. To illustrate the point of weakness where the fracture took place you are referred to Fig. 1 in which you will note that the 9 inch section of the shaft terminates with a sharp shoulder where it meets the part reduced to 6 inches in diameter. The distance between the surface of the 9 inch section and the surface of the

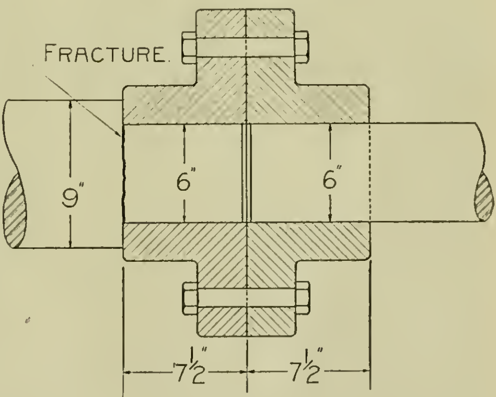
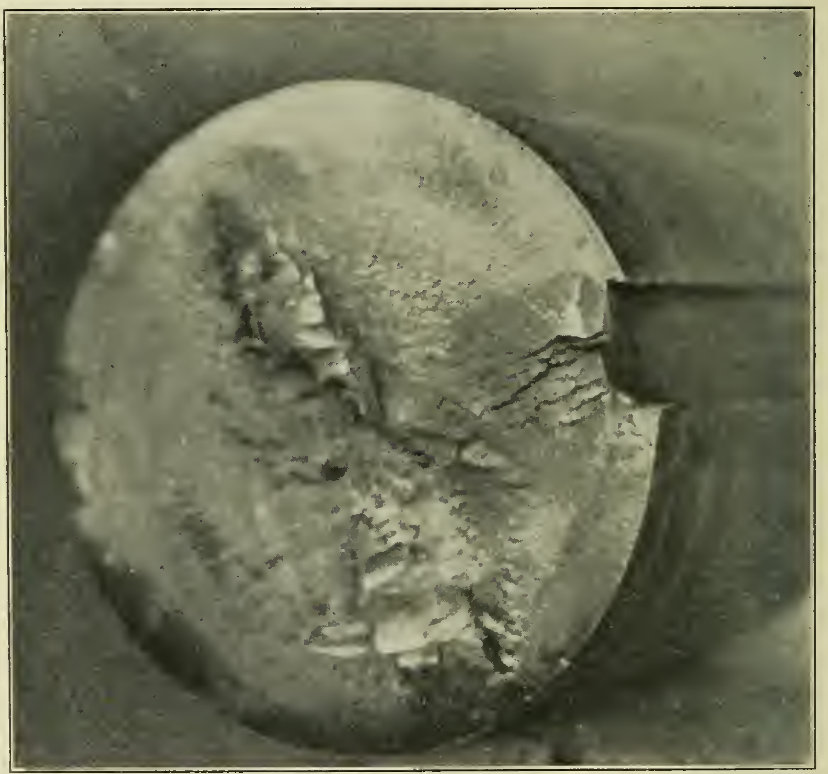


Fig. 1.

6 inch section was 1½ inches and the stresses which occurred in the cross sectional area of the 9 inch part are much less per unit of area than in that of the 6 inch diameter part because the energy transmitted is the same at all sections. In other words, we have an increase in torsional stresses at the point under discussion, which may result in the breaking down of the crystals in the material if its elastic limit is exceeded by a repetition of alternate stresses, bringing about what is known as a progressive failure.



Fracture of Engine Shaft.

The above reproduction of a photograph of the shaft under discussion, indicates that the breaking down of the metal had been gradual and had extended over a period of years, as more than half of the entire area was highly burnished, especially near the outer edge, leaving only the central section and a part under the key bed holding at the time of the break. By close examination of this figure you will note that the effect of a gradual breaking down of the material is more pronounced on a section of the area diametrically opposite the key bed, and this is accounted for by the coupling being a poor fit on the shaft. With a view of providing adequate soundness the key was fitted so that it pressed hard on the top of the key bed in the coupling thereby throwing the face out of alignment with the axis of the shaft and greatly intensifying the stress at the point of failure.

The engine in question was being operated night and day and it was very essential that repairs be made with the least possible delay. This was done by first boring out the coupling from 6 inches to 9 inches and turning off a part of the hub so that the overall length of the coupling would be 5 inches, which was the length of the shaft available after moving the outboard bearing inwards, then shrinking it and keying it on the shaft and fitting a distance piece between the flanges as shown in Fig. 2.

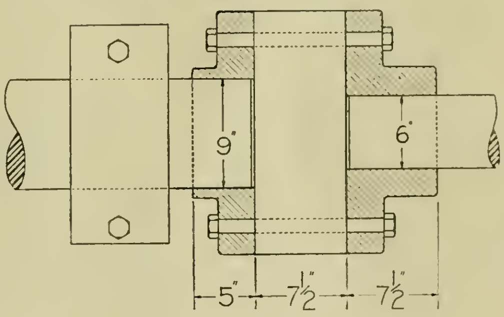


FIG. 2.

In view of the weakened condition of the coupling the service required from the engine was reduced about one-third until a few days later when permanent repairs were made by fitting and properly shrinking and keying a forged steel coupling 5 inches thick on the shaft end. The face of this coupling was turned down so as to be at 90° with the shaft. The line shaft directly connected to the engine shaft was advanced so that the distance between the faces of the couplings was reduced to 4 inches for reasons which can readily be perceived.

There are three other engines at the plant where this accident took place, the shafts of which are similar to the one that broke, and it will be seen by referring to Fig. 1 that the point where the rupture took place is inaccessible for examination. Consequently a means of determining the serviceability of the shafts of the other engines at the point under suspicion had to be devised. Before doing this it had to be taken into consideration that if a flaw was found necessitating repairs similar to those outlined, no part of the limited length of the shaft from the outer side of the outboard bearing to the point where the diameters change could be sacrificed, and after considerable thought it was determined to shorten up the over-all length of the couplings by turning off the faces of the hubs 1¼ inches and forming a fillet having a radius of ⅝ inches by undercutting the 9 inch diameter section of shaft as shown in Fig. 3. This work was done with the shaft in place, an attachment for holding properly shaped tools being bolted onto the engine bed and the engine shaft allowed to revolve under its own power the required number of turns per minute to give a proper machine finish to the surfaces operated on. After this work was done a careful examination was made by means of a powerful glass and to the satisfaction of all parties interested no indication of fracture was in evidence. A further test was made by thoroughly saturating the part examined with gasolene, then drying the surfaces and coating them with a light covering of whitewash. After this had dried the engine was placed in service for a time, then shut down and careful examination of the whitened surfaces made to detect any discoloration, for had there been any fracture, which could not be seen, the gasolene having great searching properties would have entered the crack and remained therein while the shaft was in a static condition, but would have been driven to the whitened surfaces when the shaft was in rotation, thus indicating the crack. The absence of any such discoloration proved conclusively that the shafts were serviceable.

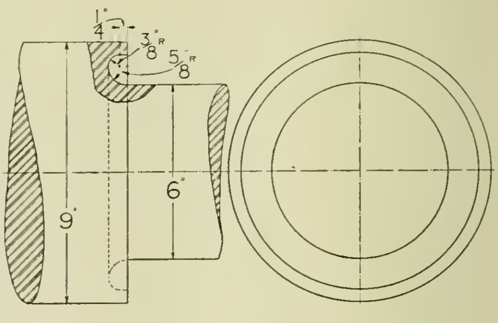


Fig. 3.

The question is now presented — to what radius shall the fillet be formed at the point where diameters change? Broadly speaking this would vary with shafts of different diameters, but the writer has yet to find a mathematical calculation that will solve this question, and in the absence of any prescribed rule arrived at by calculation and proved by actual test it is suggested that the radius of a fillet be half the difference in diameters, as shown in Fig. 4.

An article which appeared in The Locomotive, October 1922, under the title of *Fatigue of Metals*, and especially that part of it which refers to the effect of shape and degree of finish of surfaces subjected to torsional stresses, states that experiments developed on the Farmer Machine showed that test specimens having a fillet of 1 inch radius appeared to be as strong as a standard piece (one of uniform diameter). Of the others a ¼ inch radius showed an endurance limit of 92%, the square shoulder 49% and the V notch 40% of the endurance of the standard test specimen. It is very interesting to note also that a rough turned finish showed an endurance limit 18% lower than a standard finish. These test specimens were of small diameter and whereas the results of these tests cannot be considered as entirely applicable to engine shafts of various diameters, they do indicate the vital importance of a fillet at the point where diameters change in all members subject to torsion and bending stresses.

The failures of shafts of the center crank type are not at all uncommon. In some cases the break takes place across one of the crank arms and in some cases the break manifests itself at what might be termed the root of the crank pin and flush with the inner side of the crank arm. This breaking down is also of a gradual and progressive nature and brought about in most cases by allowing the balance wheel to run out of true (sidewise), or failing to keep the shaft in proper alignment. Shafts of this kind should be frequently tested for alignment and possible deflection by using an inside micrometer between the inner faces of the crank arm at four different positions of the crank travel.

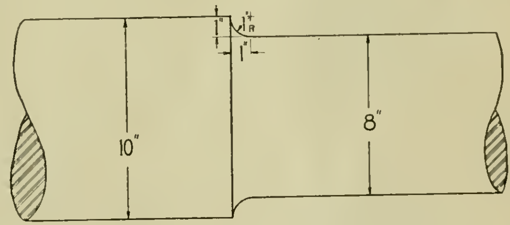


Fig. 4.

Turning now to the consideration of a crank of the disc pattern, in which the failure of the crank pin or shaft frequently causes the wrecking of the entire engine, attention is called to the changes in diameter of the pin and shaft as shown in Fig. 5. In all cases where accidents of this kind have been noted by the writer he has found that the designer had overlooked the vital necessity of providing a fillet.

We are now confronted with the question as to why it would not be proper to make the pin or shaft the same diameter from one end to the other, for the designer would have calculated the smaller diameter of ample size for the service required. There are a number of reasons for this practice, chief of which is the desire to retain all the metal possible in the disc by making the openings therein no larger than the calculations call for. Then again the sections of the pin and shaft, which enter the disc are finished to a slight taper to ensure a better fit. Furthermore, the designer in increasing the diameter of the shaft and pin has provided additional bearing surfaces for the purpose of reducing the pressure on the lubrication and of minimizing the necessity of bearing box adjustments.

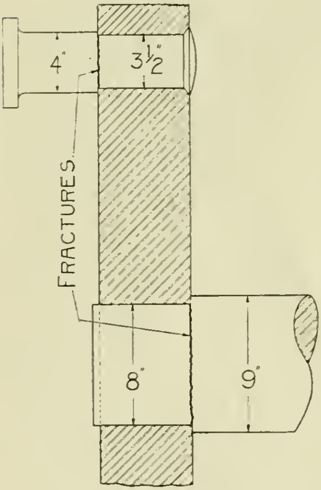


FIGURE 5.

The crank pin is subject not only to slight torsional stresses, but also at the point where the diameter changes, it is subject to shearing and bending stresses. This stress is more pronounced when the pin passes through the two dead centers and is present to some extent regardless of the amount of compression provided in the cylinder.

Whereas the forming of a fillet at the points mentioned above would entail a little more labor and expense, it deserves serious consideration, and if a similar condition is present in your engine, it should be given the proper attention.

Referring to a statement made in the early part of this article, that a test specimen having a V notch had only 40% of the endurance limit of a standard specimen, and considering how easy it is to break a steel bar that has been slightly nicked around its entire circumference, as compared with one the surface of which has not been broken, it seems probable that a decided weakness is created by such construction. However, the writer has seen engine shafting with a V notch cut at a point outside the bearing for the purpose of forming an oil stop. To remedy the condition the shaft was turned down so as to provide a suitable fillet and an oil stop made of two semi-circular pieces of light angle iron was securely attached to the shaft.

There is another form of engine breakdown similar to what has been discussed which is of a gradual and progressive nature and whereas it is not brought about by a repetition of torsion stresses, it is caused by a bending movement. This is the breaking of a piston rod at the root of the last thread on the end which is screwed into the crosshead. The breaking down of the crystals in the material which eventually brings about the final separation with its attendant damage is more likely to take place in rods of large diameter due to their lesser flexibility inherent to an increased cross section in comparison with their length than in the case of a rod with a smaller diameter. There are a number of features to be considered in connection with this part of the design of an engine, which if carefully attended to reduce to an almost negligible degree the stresses at the point under discussion. The most essential considerations are the length of connecting rod, the design of the same so as to provide suitable flexibility and the amount of clearance between the crosshead shoes and the guides. The writer has noted in a number of cases an accumulation of cylinder oil baked on the piston rod at the point where this failure takes place. Under no circumstances should this condition be allowed to exist as this part should be kept thoroughly clean and examined frequently.

The intent of this article is to disseminate information on some actual conditions found and developed by inspection, which if neglected would have resulted in breakdowns, and also to describe some conditions found after accidents have taken place, with a hope of interesting those responsible for the safe operation of steam engines, in the elimination of these sources of danger.

Over the Chief Inspector's Phone.

"Hello, this is the Engineer at Foothill Power Plant. I've just been reading a boiler book that states 'Leaks cause external corrosion and the remedy is obvious.'"

"Yes, that's right."

"Well, now can you tell me where I can get this obvious and how it is sold and applied?"

The Origin and Characteristics of Solid Fuels.

By Charles L. Wright

All living creatures require food and shelter, but one of the characteristics which differentiates man from the lower animals is his use of fuel as a source of warmth and power. Certain of the lower animals are called cold blooded and their life processes are carried on at low temperatures. Those animals which inhabit the deepest part of the oceans are perhaps extreme samples of this order. Mankind, however, with rare exceptions, has discovered the use of fire to cook his food and in the colder latitudes of the earth he has found the use of artificial heat contributed to his comfort. The use of fuel has become so necessary to highly organized society that, if our residents in colder zones were to be deprived of artificial heat in their homes, many would actually perish as a result.

The fuels which nature has given us and upon which we are now largely dependent for our heat and power are wood, natural gas, oil, and coal in its various stages of formation. The use of wood and natural gas is now being restricted for various reasons and it has been urged that more restrictions be placed on the use of oil as fuel. We may say, therefore, that the use of these fuels is comparatively limited. On the other hand, coal, particularly the variety known as " soft coal ", exists in large amounts and is our main source of fuel supply.

While several theories have been advanced as to the origin of coal, the following is the one receiving most general acceptance in accordance with our present knowledge.

When the woody material of the leaves and stems of plants falls on the ground, it soon oxidizes or decays, and the oxygen, hydrogen, carbon and nitrogen present pass into the air or soil as gases, the hydrogen and oxygen chiefly as water vapor, the carbon as carbon dioxide and the nitrogen as ammonia. Finally, of the original material, say the trunk of a great tree, only the ash, composed chiefly of silica, alumina, and iron oxide, is left. Thus it happens that the leaves, twigs and branches which have fallen for thousands of years in a forest are represented by a few inches of vegetable mold or humus, plant substance not yet oxidized to ash. If, however, the ground be covered by water, as in a swamp, air is partly excluded, and decay proceeds so slowly that vegetable or animal remains may be preserved for long periods of time. Still oxidation goes on; the dead plants gradually give up their hydrogen, oxygen and carbon as water, marsh gas, and carbon monoxide and dioxide and change to a mass of partly decayed vegetable fibre or even to a black muck.

A damp climate and a land surface from which the rainfall runs off slowly, favors the formation of extensive swamps, in which mosses, the chief vegetation in such swamps, find favorable conditions for rapid and extensive growth. The most common variety of these mosses is that known as Spaguum which has a root several feet long. Today, in Ireland, Alaska and Siberia, swampy ground is common and mosses plentiful, particularly along low coastal plains where the rivers are sluggish, and in these countries may be found large fields of a black muck known as peat which consists of the partially decayed remains of the dead mosses. Similar but smaller fields may be found in other countries.

The nature of this peat and of the coal that is mined from the depths of the earth is such that geologists have developed the theory that peat is what may be called the primary stage in the formation of coal. If we suppose such a swamp covered coast as mentioned above to sink slowly, the encroaching ocean would cover the accumulated peat and muck with sand and salt, until finally the swamp might be buried under thousands of feet of sediment. Instead of steadily sinking, however, the probabilities are that through the ages the land alternately sank and rose so that one swamp was buried over another. As the vegetable matter decayed and was compacted by the pressure of increasing layers of rock and soil, fuel substances were formed which varied greatly in composition. Those which were last formed and which underwent the least pressure contained large amounts of moisture and gaseous or " volatile " matter and small amounts of solid or " fixed " carbon. Those which were oldest and had been subjected to the greatest pressure were just the opposite in composition. The order of this formation has been, according to the scientists, first peat, which has but little fixed carbon, then lignite, bituminous or soft coal, anthracite or hard coal, and lastly graphite, which is practically pure carbon.

This loss of water and of volatile matter in the change from peat to coal, caused a great loss in bulk. The pressure of overlying strata, or of earth movements that warped and folded the rock formation, reduced the bulk still more. Thus it may happen that a coal seam one foot thick may represent what was 50 feet of peat in the ancient swamp, and it is fair to assume that an average seam of true coal is not one-fifth the thickness of the original peat beds.

Various elaborate schemes of classifying coal have been advocated but have not gained popular acceptance. In fact several methods suggested for classifying coal are useful only for purely scientific purposes and could be interpreted only by a trained chemist or combustion engineer. While these methods are useful for research purposes in the general advancement of scientific knowledge, such as studying the relation of the carbon to the hydrogen in the various types of fuels, yet to the man directly interested in the utilization of the fuel, a classification according to the results of a " proximate analysis " is more practical as fuels are more commonly bought and tested on a proximate analysis basis than on the so-called " ultimate analysis."

A proximate analysis determines the moisture, the volatile matter (easily gasified portion), the fixed carbon, the ash and, if desired, the sulphur. These, together with the heat value as determined with a calorimeter, are sufficient for most commercial purposes. For scientific purposes however, the ultimate analysis is of value and this determines the following characteristics of a fuel: the uncombined water, the carbon, the hydrogen, the oxygen, the nitrogen, the sulphur, and the ash. The results of either analysis are reported in percentage.

The coal fields of the world are widely distributed and statistics show that the more civilized countries have developed their fuel resources to a greater extent than those less civilized. As coal was much sought after in the past, so the resources of petroleum oil, another source of power, now are involving nations in controversies as to ownership or control.

As it is the aim of this article to give the operating engineer and superintendent practical information in regard to the fuel problem, no attempt will be made to go deeply into the geological or chemical study of fuels. At this point, however, it may be well to say a few words about the moisture in fuels.

Moisture in fuels is of two kinds — the " surface moisture " or that which is given off by exposing the fuel to air at the ordinary temperature and the " combined moisture " or that which is removed by a temperature of 220° F. Of course if the surface moisture is not first removed by air drying it will evaporate with the combined moisture when this test is made. The sum of the " surface" and "combined" moisture makes the "total" moisture. Lignite is high in moisture content while anthracite is low.

According to the U. S. Bureau of Mines and other references, solid fuels of the United States may be classified on a moisture and ash free basis according to their volatile matter and fixed carbon content as follows: —

Classification of Dry Fuels by Combustible Content

Kind of Coal	Percent of Combustible		B. T. U. Per pound of dry Combustible
	Fixed Carbon	Volatile Matter	
Anthracite	97 to 92.5	3 to 7.5	14600 to 14800
Semi-anthracite	92.5 to 87.5	7.5 to 12.5	14700 to 15500
Semi-bituminous	87.5 to 75	12.5 to 25	15500 to 16000
Bituminous-Eastern	75 to 60	25 to 40	14800 to 15300
Bituminous-Western	65 to 50	35 to 50	13500 to 14800
Lignite	50 to 37	50 to 63	11000 to 13500
Peat	37 to 29	63 to 71	9400 to 10400
Wood	25 to 20	75 to 80	8000 to 9000

The fuel materials vary considerably as the following description of their characteristics will show.

Wood has been used as a fuel from the earliest times but the introduction of coal, which costs less per unit of heat value than wood and is more convenient to transport and use, has resulted in the practical elimination of wood as a fuel except in isolated rural districts far from a coal supply. Wood is low in ash but high in moisture, containing in the unseasoned condition over 50%, while in seasoned wood the moisture content will average from 20 to 30%. Wood varies in heat value over a wide range according to the variety and state of dryness but 6000 B. T. U. per pound is a fair average heat value for seasoned cord wood. A cord of well seasoned hard wood will weigh about 4000 lbs. while pine wood will weigh only about 2000 lbs. to the cord. For practical purposes, we may consider two cords of average soft wood as approximately equal in heat value to one ton of anthracite or medium grade bituminous coal, while one cord of hard wood will contain about the same number of heat units as a ton of average house or steam coal.

Peat, one of the lowest forms of fuel, is derived from moss and is found in bogs. It is used as a house fuel in some European countries, notably Ireland and Sweden. If used without machining or briquetting, the peat is cut in the summer and fall into pieces about 8 inches each way which are stacked up and dried to form blocks of sufficient strength to handle. If not stored under cover, peat blocks are disintegrated badly by the weather. As dug from the ground, peat contains from 75 to 95% of water and a moisture equilibrium requires from 15 to 30% of water be left in the air dried peat. A consideration of this high amount of moisture will show that peat is a very poor fuel and likely to be used only in those countries where no other fuel is available.

The fuel value of air dried peat is from 6000 to 8000 B. T. U. per lb. and under test conditions air dried peat gives an equivalent evaporation of 3 to 4 lbs. of water per lb. fuel and a boiler efficiency of 50%. Peat beds are found in Maine, Connecticut, New Hampshire, Massachusetts, New York, Michigan, Wisconsin, the Dakotas, Florida and some of the other southern states.

Lignite is a fuel of greater age than peat but like the latter is high in moisture in the natural condition. In Germany, lignite is used to a considerable extent as both a household and industrial fuel. While the Germans divide their lignite into six different grades, in the United States it is customary to classify lignites as either brown lignite or black lignite, the latter being more commonly known as sub-bituminous coal and will be described later under that name.

The brown lignites are either woody or like earth or loam in texture, some of them in Germany being readily cut with a spade. Lignites are non-caking and burn with a slightly smoky flame, giving off a pungent characteristic odor. The specific gravity ranges from 1.2 to 1.23. The ash content in lignite averages from 5 to 10% or about the same as bituminous coal but the moisture is always higher than bituminous. American lignite fresh from the mines contains between 30 and 40% of moisture while German lignites have as high as 60% of moisture. Lignite possesses a tendency to "slack," that is to say, it gives up a part of its moisture on exposure to the air and breaks up into little flakes or pieces, reaching a stable condition when from 5 to 15% of moisture remains, the amount varying with the different samples. At the present time lignite in the United States is of only local importance as its low heat value, which is only 6000 to 7000 in the raw fuel, does not warrant its shipment far from where it is mined. Its tendency to spontaneous combustion is another feature which prevents the storage of this fuel in large quantities, as lignite is more liable to spontaneous combustion than the average bituminous or anthracite coals.

The lignites of the United States are found in Texas, North Dakota, California and Montana.

The fixed carbon of lignite is non-caking and does not form coke when heated. This makes it difficult to burn the slack of lignite on an ordinary grate but when special grates, such as the step grates are used, this difficulty is overcome.

Bituminous or soft coal has, strictly speaking, several gradations. The lowest grade of soft coal is sub-bituminous or black lignite and this type of coal possesses some characteristics of both true bituminous coal and lignite. Its structure shows little trace of its woody origin, in this respect resembling bituminous coal. On the other hand, it resembles lignite because it tends to dry out and slack down to dust when exposed to the air. These sub-bituminous coals contain from 35 to 45 per cent. of volatile matter, and moisture in the vein sample averages from 17 to 20 per cent.

The true bituminous coals of the United States may be classified as the Eastern and Mid-Continental. This type of coal is rich in tarry or bituminous matter which furnishes a high volatile content. When heated this volatile matter breaks down into gases, oils and tars.

The specific gravity of bituminous coals varies from 1.25 to 1.4 and their colors vary from a brown to jet black. Their hardness varies also over a wide range, the harder varieties having the higher heat values. The surface moisture of bituminous coals can be largely reduced by storage under cover but the combined moisture is expelled only by a temperature above 212° F. Bituminous coals burn with a yellow flame, and smoke and soot are usually formed unless special conditions are provided for burning this fuel. This fuel is called caking if it forms coke when burning or non-caking if the carbon remains granular during combustion. The non-caking coals are also known as free burning. Caking coals are richer in volatile matter than the non-caking and are therefore particularly valuable for gas manufacture and coke making, but the non-caking coals burn more freely and do not fuse together, being therefore more useful as steaming coals. Bituminous coal has a volatile content of 25 to 35% in the eastern part of the United States while it may reach as high as 45% in the Central States. The eastern bituminous coals absorb or hold little moisture, averaging from 2 to 4 per cent, but the bituminous coals of the Central States average from 6 to 17 per cent. of moisture.

Semi-bituminous or low volatile bituminous coals are especially valuable for steaming as they are high in heat value and low in ash and make much less smoke than the high volatile bituminous coals. These coals vary from 15 to 22% in volatile matter and the moisture content is seldom over 3% and is frequently below 1%. The New River and Pocahontas coals are well known examples of this grade of bituminous and these and other coals are much in demand as steamship fuel. Some of these semi-bituminous coals, while possessing wonderful heat value and steaming qualities, are subject to one drawback, namely their friability or brittleness which makes them break up easily on handling. If special equipment is available for burning the slack or fines, this characteristic is not harmful, but it does decrease their usefulness as export fuel for trade that is used to handling block or lump fuel. This is the reason why some European fuel is more acceptable to South American trade, even if this fuel is lower in heat value than the American fuel because the former reaches its destination in more acceptable sized pieces than the latter.

Semi-anthracite is a grade of coal that is harder and of greater density than semi-bituminous coal but containing less volatile matter and less heat value than this latter fuel. A new fracture of semi-anthracite will soot the hands while that of true anthracite will not. Semi-anthracite is generally free burning, and smokeless. These characteristics together with its high heat value make it an ideal fuel for steam generation.

Anthracite or as it is more commonly called, "hard coal," is a type of coal that has the highest proportion of fixed carbon of any coal and therefore the proportion of volatile or smoke producing gases are low in this fuel (less than 5%) and so it makes an ideal household fuel. As its production is limited, it is available only to parts of the United States. Pennsylvania furnishes the entire supply of anthracite produced in this country and while a limited quantity of this fuel is shipped in to the central western states, the great bulk of it is used in New England and the Middle Atlantic States for house heating. The finer sizes have found an outlet as a fuel for heating office buildings in cities having smoke ordinances. The beds of anthracite have layers of slate in them and require careful sorting and picking over to remove this impurity. Anthracite is not easily ignited, and is practically free from danger of spontaneous combustion. It has a specific gravity varying from 1.3 to 1.8. When heated it burns with a short yellow flame, if any, but frequently the conditions in an anthracite fire are favorable to the formation of carbon monoxide which burns with the characteristic blue flame noticeable over the fire when the fire door is opened. Anthracite does not swell up or form a coke during the combustion as some bituminous coals do. In texture, anthracite coal is hard like stone, and true anthracite will not soil the hands when freshly fractured, differing in this respect from semi-anthracite.

In heat value, anthracite is lower than the best grades of bituminous averaging 12,500 to 13,300 B. T. U.s in the condition as shipped. Unless carefully prepared at the mine, the impurities will cause a high ash content in this fuel, and from 15 to 20% of ash is frequently present in shipments of this fuel.

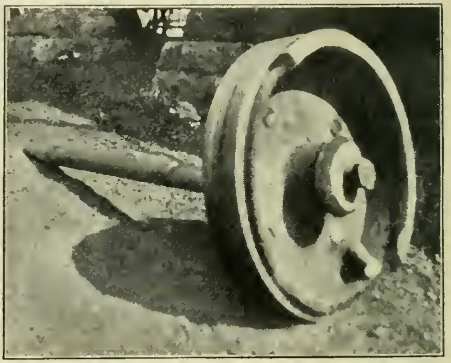
A Piston Explosion.

By Inspector C. B. Bailey

MANY curious and unusual explosions have been recorded in former numbers of The Locomotive but the following account of the explosion of a piston during an attempt to remove it from the piston rod is interesting both as a unique explosion and also as a warning of danger under similar conditions.

A method was tried out recently at a plant in Pennsylvania for removing a piston from the piston rod of a pump 36 x 48 x 16 inches, located in a mine and used for pumping mine water. The piston rod had become bent and was removed from the cylinder with the piston attached to it. After trying a few times to remove this rod from the piston while it was still in the mine without avail, it was taken outside to the machine shop, where heavy wrenches were applied, but the rod was so set that it would not budge. It was then decided to try the heating process for its removal. The piston was made of cast iron 36 inches in diameter, and 1¼ inches thick, with a hub 9 inches in diameter and 4 cores or posts each 2 inches in diameter. It was 5½ inches deep and after a deduction for the cores and the hub there was left 3.07 cu. ft. of volume within the piston. There were some small sand holes in the piston and apparently while the engine was in operation some steam entered the interior of the piston through these sand holes and condensed there.

The workmen, six in number, did not realize or give this matter thoughtful consideration when a wood fire was built around the piston, which was brought out of the mine at 9 A. M. and had been worked on until 11 A. M. before building the fire. The fire was allowed to heat the piston a little and then it was removed from the fire and another try was made at removing the rod. The fire was applied to the piston off and on for an hour. The noon whistle blew and the six men left for dinner and had not gone more than a hundred feet from the spot when the piston exploded. The explosion was so terrific that the flying pieces of metal did considerable property damage. The largest piece left the machine shop yard and landed about 75 feet away. All the window-panes and sash were blown from the front of the building and one flying piece of metal struck a 13-inch brick wall making an opening about 20 inches in diameter and just below that another smaller hole. A heavy door was lifted from its hinges and a mine cage resting on trestlework nearby was partly damaged so that it certainly was providential that the whistle blew at 12 o'clock and no one was hurt by the explosion. If any of the readers of THE LOCOMOTIVE should have occasion to remove a rod from a piston by this method, it would be well to first remove the plugs or tap the piston before applying the heat. To be on the safe side, the proper way would be, if the rod has set, to drill it out. A faint idea of the stored energy in a boiler can be obtained by considering the effects resulting from the energy stored in this piston in a space of only 3.07 cu. ft.



AN EXPLODED PISTON.

A colored workman on the job said after the accident that; "I sur du now, Boss, believe in SAFETY FIRST."

On Laying Up The Furnace.

THOUGH coal is cheaper in the summer the problem at such times is one of cooling, rather than heating, consequently the furnace should be laid up in the spring, ready for use the following October. Those who have had experience in matters like this know that the first step of the process, and the most important, is to let the fire go out. Ordinarily the fire will do this of its own accord if it is still winter, but if the furnace realizes that the end of spring is at hand it will display more activity than a rich relative of many years.

In any event, if the fire is to be stopped, coal must not be fed to the furnace. Such coal will keep despite warm weather and may come in handy for throwing at stray cats.

After the fire is out the ashes should be removed, either in person or by proxy. Hardened suburbanites let the ashman do this, for while the ash pit is seldom over sixteen inches square its contents, have been known to run into the hundreds of bushels.

All upright furnaces have a goodly number of cleanouts located in surprising and unsuspected places about their anatomy. Great ingenuity is used by the designer in this connection, because a furnace having the greatest number always receives the blue ribbon at expositions. Hard as it is to design a furnace with an unlimited number of these cleanouts, it is still harder to find them when wanted and, when found, to remove their covers. The combinations of safes are much easier.

Some householders have a misconception of the relation of the furnace to the smoke pipe. It is true that for certain purposes one is contingent upon the other, but the smoke pipe is not necessary for the support of the furnace. Consequently the latter need not be removed in order to take down the smoke pipe. As a matter of fact, it is very often the only support of this pipe.

When the smoke pipe is finally down the soot still remaining in its interior should be removed. The amount so obtained subtracted from that formerly in the pipe will give the difference between the two — this difference will be found on the householder's shirt front.

It is an unnecessary expense to remove air or cold steam from the pipes, as neither of these can be used in the garden. The situation is different, however, in hot water systems, for in such

(Continued on Page 184)

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, Editor. C. L. WRIGHT, Assistant Editor.

HARTFORD, APRIL, 1923.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

IF we were to fasten a bar of iron in a vise and bend it over at a sharp angle, we would weaken the bar of iron at the point where it was bent and we would not have to repeat this bending many times before the iron would break off at this point. If, on the other hand, we bend this iron bar around a curved form of large radius, it would not be perceptibly weakened.

The results would differ because when a sharp bend is made the necessary elongation must come from a relatively short length of the bar,— the length that would be stretched being dependent on the ductility or plasticity of the metal — and excessive elongation may carry the stresses in the bar to the breaking point as would be shown by cracks on the surface. In the case of bending about a large radius, opportunity is given a greater length of metal to share in the necessary elongation so that the unit stresses do not reach such extreme values. Somewhat the same action might be considered as taking place in the case of shafting subject to shearing and bending. If fillets are not used in shoulders where such shafts change to smaller diameter, the tendency to break at this point is naturally greater than in similar cases of reduction of diameters where fillets are used. The article in this issue on the " Importance of Fillets in Engine Shafts and Crankpins " throws some interesting light on this subject which deserves the thoughtful consideration of designers of engines and machines of various kinds in which this principle of fillets is involved.

Electrical Machinery Insurance.

IT is perhaps a matter of common observation that the past decade has witnessed a remarkable development of mechanical power. Today the use of power is growing by leaps and bounds and this growth is largely due to the facility with which electricity can be generated, transmitted and adapted to our needs. Every step forward in our civilized life has been attended, however, with increasing risk and the use of electricity has proved no exception to the rule. Realizing this, The Hartford Steam Boiler Inspection and Insurance Company now offers, through its Electrical Machinery Policy, the same protection that has been available for over half a century to the users of steam boilers and for a considerable number of years to the users of steam engines and turbines.

The Hartford Electrical Machinery Policies indemnify for loss caused by a breakdown, that is, a sudden, accidental breakage or burnout of a piece of electrical machinery of such character as immediately prevents its continued operation. It thus pays for those many breakdowns of either a mechanical or electrical nature which occur in the operation of such machines and which make necessary extensive and expensive repairs before their operation may be resumed.

Inspections are made by men who are well versed in the use of electrical machinery and who are specialists in their line. As in the case of the Hartford's boiler inspections, their visits are made periodically to ascertain the condition of the equipment and to advise concerning its safe and economical use.

At the present time electrical inspectors are located in all departments of the Company with the exception of the Denver, San Francisco and Portland offices. The Company is prepared therefore to write its electrical machinery policies in all territory east of Denver and will soon develop its organization so as to render service in all its departments.

Personal.

THE Hartford Steam Boiler Inspection and Insurance Company takes pleasure in announcing through the medium of this publication the appointment of Mr. Kenneth A. Reed as Electrical Engineer. Mr. Reed has been in charge of the newly formed Electrical Department of the Company since its inception January 1st, 1921. After graduating from the University of Arkansas in 1907 with the degree of B.E.E., Mr. Reed was employed with the Allis-Chalmers Company, taking their student's course at the Bullock Works in Cincinnati. Shortly after the completion of this course he accepted a position with the Northwest Light and Water Company of North Yakima, Washington, where he was engaged in central station and development work. After about two years in this work he became identified with the Westinghouse Electric and Manufacturing Company in their St. Louis District. The early part of his eight and one-half years service with this company was devoted to construction work and later he held the position of Assistant District Service Manager. In September 1918 he accepted the position of Maintenance Engineer in the Electrical Operating Division of the Interborough Rapid Transit Company of New York having charge of the maintenance of that company's central power stations and substations. This position he held until he entered on his new duties with the Hartford Company.

Through the training and experience thus acquired Mr. Reed is excellently fitted for the position which he holds and which calls for a thorough knowledge of the engineering side of electrical machinery insurance. He is well acquainted with the hazards of operation of such equipment, with the care that must be given it and with the inspection service that is necessary to promote continuous operation.

Obituary.

ON February 27th, 1923, there passed away at his home in Duluth, Minn., a man whose strong character, keen intellect and public spirit had made him an outstanding figure in that community. This man was Trevanion W. Hugo, who had been a member of the HARTFORD'S organization since 1888 and its resident agent at Duluth for many years. Those of our Company who knew him and many of us who never had the privilege of making his acquaintance but knew of him, feel deep sorrow and regret at the termination of this long association with one who so ably and devotedly served our company and so firmly established its reputation among the boiler-users of his district. We have always felt proud of the confidence in which our Duluth representative was held by his fellow citizens and of the honors which he received at their hands. We now sincerely share in the sorrow and sense of loss which his death brings to that city.

Mr. Hugo was a Cornishman by birth. He came with his parents to America at an early age and received his education here. Leaving school, his aptitude for mechanical pursuits led him to go in for steam engineering as a profession. After an experience of several years on lake steamers, he went to Duluth in 1881, and as an engineer began to take his part in the upbuilding and developing of that industrial center. He was consulting engineer for many of its largest elevator plants and made his initial connection with The Hartford Steam Boiler Inspection & Insurance Company largely because he realized that it could render through him great service to the steam-users in his growing community.

But it was not as an engineer alone that Mr. Hugo's life is distinguished. He had pre-eminently the spirit of loyal service. He was a man of keen intellect and sound judgment. These qualities were recognized by his fellow citizens and in succession he was elected alderman, president of the City Council, member of the Public Library Board and in the year 1900 was honored with the mayoralty of the city, serving in that position for four years. On his retirement from that position, he continued a member of the School Board of which he was president for many years. In 1920 he received the distinguished compliment of a unanimous call from the Commissioners of Duluth to act as Mayor in filling out the unexpired term of Mayor Hagney, who had resigned.

Mr. Hugo was nationally prominent in the Masonic fraternity. He became a Mason early in his career and his interest in and devotion to Masonry continued all his life and was rewarded by signal honors at the hands of his fellows. The degrees conferred on him were numerous and at the time of his death he was Grand Chancellor of the Supreme Council Scottish Rite of Freemasonry and Sovereign Grand Inspector General of Minnesota.

In private life Mr. Hugo was a man of warm affections and of deep culture. Courteous and kindly, he won and held the respect and affections of those with whom he came in contact. In an editorial on his death, the Duluth News-Tribune sums up his character and qualities in the following tribute: "A cultured gentleman in the best American meaning of the word, a public-spirited citizen of the highest type, and a kindly courteous acquaintance and friend, Trevanion W. Hugo will be keenly missed in Duluth. Few men better deserved the title of useful citizen."

A Correction.

An explosion which occurred at the State House, Boston, Mass., on February 1, 1922 was listed as boiler explosion No. 117 in the January issue of The Locomotive, in accordance with a statement appearing in a Boston newspaper. We are now informed that this accident was not a boiler explosion but the bursting of an engine cylinder head and we therefore call attention to this correction.

On Laying Up The Furnace.

(Continued From Page 179)

systems the water can be drained off to the garden. All that is required for this purpose is a few hundred feet of hose.

The system should not be refilled until empty, and then only regulation water should be used, as seltzer waters and the like produce strange noises, especially in the expansion tank.

Directions are sent with each furnace, but many owners fail to carry these out faithfully. The exterior of the furnace is not always blackened and polished as per such instructions, though the manufacturer's name should certainly be gilded over each year.

A word of caution is necessary with any system — "The outdoor thermometer must be watched." This is a good thing to remember, and it will stand twice telling — "Always look at the thermometer when through laying up system, watch the mercury carefully, and it will then be found going in the direction of zero."

— *N. Y. Evening Sun.*

Summary of Inspectors' Work for 1922.

Number of visits of inspection made	231,881
Total number of boilers examined	453,065
Number inspected internally	165,947
Number tested by hydrostatic pressure	10,398
Number of boilers found to be uninsurable	985
Number of shop boilers inspected	12,441
Number of fly-wheels inspected	45,417
Number of premises where pipe lines were inspected	16,241

SUMMARY OF DEFECTS DISCOVERED.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	33,385	1,852
Cases of adhering scale	49,565	1,947
Cases of grooving	2,048	224
Cases of internal corrosion	25,647	1,059
Cases of external corrosion	12,800	1,135
Cases of defective bracing	958	302
Cases of defective staybolting	3,457	800
Settings defective	10,151	1,052
Fractured plates and heads	4,342	700
Burned plates	3,809	509
Laminated plates	383	69
Cases of defective riveting	1,517	432
Cases of leakage around tubes	13,561	1,760
Cases of defective tubes or flues	22,230	7,355
Cases of leakage at seams	6,634	565
Water gauges defective	5,380	1,012
Blow-offs defective	5,326	1,692
Cases of low water	393	145
Safety-valves overloaded	1,400	421
Safety-valves defective	2,157	511
Pressure gauges defective	8,181	730
Boilers without pressure gauges	837	122
Miscellaneous defects	8,365	1,113
Total	222,525	25,505

GRAND TOTAL OF THE INSPECTORS' WORK FROM THE TIME THE COMPANY BEGAN BUSINESS, TO JANUARY 1, 1923.

Visits of inspection made	5,403,515
Whole number of inspections (both internal and external)	10,685,853
Complete internal inspections	4,172,718
Boilers tested by hydrostatic pressure	398,160
Total number of boilers condemned	30,731
Total number of defects discovered	5,941,036
Total number of dangerous defects discovered	655,823

FLY-WHEEL EXPLOSIONS DURING 1922.

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	Jan.	1	Brake wheel of turbine testing machine exploded	1	2	Kerr Turbine Works	Turbine Factory	Oil City, Pa.
2	Jan.	1	8 ft. fly-wheel exploded			Liberty Tunnel		Pittsburgh, Pa.
3	Jan.	7	Steam turbine exploded			Comanche Light Co	Elec. Power Plant	Lawton, Okla.
4	Feb.	14	Barrel head cutter wheel exploded	1	2	Georgia Stove Co.	Barrel Factory	Valdosta, Ga.
5	Feb.	19	Steam turbine exploded by overspeeding		1	Thomas A. Edison	Power Plant	West Orange, N.J.
6	Feb.	23	Fly-wheel exploded			The Burden Iron Co.	Iron Works	Troy, N. Y.
7	Feb.	27	Fly-wheel exploded	1		Gilchrist Fordney Lumber Co.	Lumber Mill	Laurel, Miss.
8	Mar.	1	Steam turbine exploded			Puget Sound Power Co.	Power Plant	Seattle, Wash.
9	Mar.	9	Water turbine exploded			Glens Power Plant	Power Plant	Rutland, Vt.
10	Mar.	20	Fly-wheel of small gasoline engine exploded		1	Frank Cieslewicz	Farm	Iola, Wis.
11	Apr.	8	Two large circular saws exploded		1	Jack Spencer	Sawmill	McCrory, Ark.
12	May	22	Main driven pulley exploded			Hanna Paper Co.	Paper Mill	Watertown, N. Y.
13	June	6	Fly-wheel exploded			Merchants Ice Co.	Ice Plant	Harrisburg, Pa.
14	June	28	Fly-wheel exploded	1		Herman Holmes	Lumber Mill	Iron River, Mich.
15	July	5	Fly-wheel exploded			Republic Ice Co.	Ice Plant	New Orleans, La.
16	July	6	Fly-wheel exploded			Indiana Rolling Mill	Rolling Mill	Newcastle, Ind.
17	July	7	Fly-wheel of wood saw exploded		1		W'd Saw'g Outfit	Sandy, Ore.
18	July	10	Wheel exploded			Escanaba Paper Co.	Paper Mill	Escanaba, Mich.
19	July	13	Fly-wheel exploded	1		Crescent Creamery Co.	Creamery	Los Angeles. Cal.
20	July	16	Fly-wheel hub cracked			City of Augusta	Power Plant	Augusta, Kan.
21	July	24	Fly-wheel exploded		1	American Railway Express Co.	Express Company	Cleveland, O.
22	July	30	Fly-wheel exploded			Wolverine Portland Cement Co.	Cement	Jackson, Mich.
23	Aug.	7	Fly-wheel exploded			Newton Link	Pumping Plant	Eunice, La.
24	Aug.	8	Fly-wheel exploded	1		Mistner & Steele		Morris, Okla.
25	Aug.	10	Turbo water pump exploded	1		Parkhill Mfg. Co.		Fitchburg, Mass.
26	Aug.	18	Threshing machine fly-wheel exploded		1	Isaac Kachins	Farm	Hatboro, Pa.
27	Aug.	29	Fly-wheel exploded		1	Willipa Lumber Co.	Lumber Mill	Raymond, Wash.
28	Aug.	31	Drum of hoisting engine exploded			Newport Mining Co.	Mine	Ironwood, Mich.
29	Sept.	4	Fly-wheel exploded			Town of Ladysmith	Lighting Plant	Ladysmith, Wis.
30	Sept.	10	Pulley burst			Hanna Paper Co.	Paper Mill	Watertown, N. Y.

FLY-WHEEL EXPLOSIONS.

(Continued)

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
31	Oct.	8	Four ton fly-wheel exploded			Ingle No. 7 Mine	Coal Mine	Ayrshire Ind.
32	Oct.	15	Fly-wheel exploded			Carnegie Steel Company	Steel Plant	Sharon, Pa.
33	Oct.	28	Governor and pulley wheels exploded		2	Village of Westfield	Power Plant	Westfield, N. Y.
34	Oct.	28	Pulley and shaft broke			National Lead Co.	Lead Works	New York, N. Y.
35	Nov.	6	Steam turbine exploded	1		Trinity Portland Cement Co.	Cement Plant	Dallas, Tex.
36	Nov.	9	Steam turbine exploded			City of Hibbing	Power Plant	Hibbing, Minn.
37	Nov.	16	Fly-wheel exploded			Anderson-Tully Co.	Veneer & Box Factory	Memphis, Tenn.
38	Dec.	12	Motor Saw fly-wheel exploded	1		George A. Young	Farm	Montgom'y, N. Y.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF MARCH, 1922 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
201	6	Sheet bulged and staybolts failed			Clinton Cotton Mills	Cotton Factory	Clinton, N. C.
202	7	Air tank exploded	3	14	Kansas City Railroad Co.	Car Barn	Kansas City, Mo.
203	7	Boiler exploded		2	J. C. Miller	Saw Mill	Gilmer, Tex.
204	7	Blow off pipe failed at elbow			Otter River Board Co.	Paper Mill	Otter River, Mass.
205	8	Two sections of heating boiler cracked			Phoenix Hotel Co.	Hotel	Findlay, O.
206	8	Tube ruptured			Buckeye Cotton Oil Co.	Cotton Oil Plant	Jackson, Miss.
207	8	Hoisting boiler exploded		1	Navy Yard		Norfolk, Va.
208	8	Section of heating boiler cracked			Central Metal Products Co.	Metal Works	Canton, O.
209	8	Section of heating boiler cracked			Wooley & Hughes, Inc.	Offices & Sal'room	New York, N. Y.
210	9	Section of heating boiler exploded	1		Y. M. C. A.	Y. M. C. A. Bldg.	Beaumont, Tex.
211	9	Blow off pipe failed			Otter River Board Co.	Paper Mill	Otter River, Mass.
212	9	All sections of heating boiler cracked			Jacob Gordon	Apmt. House	New York, N. Y.

213	9	Section of heating boiler cracked			Mt. Oliver School Dist.	School	Pittsburgh, Pa.
214	10	Tube of power boiler failed			Bryant Paper Co.	Paper Mill	Kalamazoo, Mich.
215	10	Section of heating boiler cracked			Julesburg Heating Co.	Heating Plant	Julesburg, Colo.
216	10	Manifold of power boiler cracked			F. M. Cottrell	Hotel	Boston, Mass.
217	11	Section of heating boiler cracked			Board of Education	High School	TraverseCity,Mich.
218	12	Seventeen sections of heating boiler cracked			William Fox	Theater	Brooklyn, N. Y.
219	13	Boiler sheets burned			American Car & Foundry Co.	Car Plant	Wilmington, Del.
220	13	Tube ruptured			Woodward Iron Co.	Iron Plant	Woodward, Ala.
221	14	Boiler feed pipe burst			Joseph Wild & Co.	Carpet Factory	Brooklyn, N. Y.
222	14	Ammonia generator tank cracked			F. A. Ferris & Co., Inc.	Packing Plant	New York, N. Y.
223	15	Section of heating boiler cracked			School District	School	Wilkinsburg, Pa.
224	15	Three sections of heating boiler cracked			Jos. H. Levey & Sons, Inc.	Apmt. House	New York, N. Y.
225	15	Boiler of locomotive exploded	1	3	Mobile & Ohio R. R.	Railroad	Egypt, Miss.
226	15	Boiler exploded	2		Gamble & Dewese	Saw Mill	Philadelphia, Miss.
227	15	Section of heating boiler cracked			Kokomo Trust Co.	Bank	Kokomo, Ind.
228	16	Boiler exploded		3	Kempe Bend Gravel Co.	Gravel Plant	Vidalia, La.
229	16	Air tank exploded			Charles S. Schmitt	Gasoline Station	St. Louis, Mo.
230	16	Girth seam leaked			Chrystal Ice Co.	Ice Plant	Union City, Tenn.
231	18	Tube ruptured			City of Canton	Elec. L. & W. Wks	Canton, Miss.
232	19	Four sections of heating boiler cracked			Jos. H. Levey & Sons, Inc.	Apmt. House	New York, N. Y.
233	19	Tube collapsed			Greenville Stone & Gravel Co.	Gravel Dredge	Greenville, Miss.
234	20	Two sections of heating boiler cracked			Board of Education	School	Canton, O.
235	20	Boiler exploded	1	3	Newton S. Stowell	Spool Stock Mill	West Byron, Me.
236	20	Boiler tube ruptured		2	Endicott Water Works	Water Works	Johnson City, N.Y.
237	20	Furnace collapsed			Massachusetts Laundry Co.	Laundry	Detroit, Mich.
238	20	Section and five tubes of heating boiler cracked			Robt. Findlay Mfg. Co.	Factory	Brooklyn, N. Y.
239	21	Four headers of heating boiler cracked				Oil Refinery	Pasadena, Tex.
240	24	Boiler settled and broke blow off pipe			Mogadore Insulator Co.	Insulator Factory	Mogadore, O.
241	24	Crown sheet bulged and staybolts loosened			Sprukes Co.	Coal Stripping	Scranton, Pa.
242	25	Cast iron heating boiler exploded			Newhall Bldg.	Office Bldg.	San Fr'cisco, Cal.
243	26	Boiler exploded	4	7	Steamer Omer D. Conger	Ferry Seamer	Port Huron, Mich.
244	26	Tube ruptured at weld and pulled out			Woodward Iron Co.	Iron Plant	Woodward, Ala.
245	27	Oil tank exploded	2		Pennsylvania Railroad	Railroad R'dhouse	Columbus, Ind.
246	27	Small power boiler exploded		1	Climn Warehouse	Warehouse	Lemoore, Cal.
247	27	Hot water boiler exploded			Hurd Creamery Co.	Creamery	Omaha, Nebr.
248	27	Four sections of heating boiler cracked			Strand Theater Corp.	Theater	Sharon, Pa.

MONTH OF MARCH, 1922 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
249	27	Two section of heating boiler cracked			Joanna M. O'Rourke	Apmt. House	New York, N. Y.
250	27	Section of heating boiler cracked			Jennie I. Gray	Apmt. House	San Fr'cisco, Cal.
251	28	Rear header of power boiler cracked			Public Service Corp. of N. J.	Power Plant	Newark, N. J.
252	28	Blow off pipe failed			E. G. Hills Co.	Florist	Richmond, Ind.
253	28	Section of heating boiler cracked			T. D. Cook & Co.	Mercantile Bldg.	Boston, Mass.
254	29	Section of heating boiler cracked			Phoenix Commercial Co.		New York, N. Y.
255	29	Rear header of power boiler cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
256	30	Tube failed			Elect. Lt. & Water Comm.	Heat & Power Sta.	Lansing, Mich.
257	31	Tube failed			Middle West Utilities Co.	Elec. Power Sta.	Williams, Ind.

MONTH OF APRIL, 1922.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
258	1	Four sections of heating boiler cracked			Michigan Home Furnishing Corp.	House Furnishings	New York, N. Y.
259	1	Tube ruptured in low pressure boiler			W. W. Laundry Co.	Laundry	Oil City, Pa.
260	1	Two headers of power boiler cracked			Fawcus Machine Co.	Machine Shop	Ford City, Pa.
261	1	Economizer tube ruptured			Simmons Company	Bed Factory	Kenosha, Wis.
262	1	Boiler bulged and ruptured			Henryellen Coal Co.	Coal Mine	Henryellen, Ala.
263	1	Four sections of heating boiler cracked			Jenks Paper Box Co.	Paper Box Fact'y	Providence, R. I.
264	1	V. T. Boiler ruptured			W. R. Pickering Lumber Co.	Lumber Mill	Haslam, Tex.
265	1	Section of heating boiler cracked			Northwestern Bell Telephone	Telephone Bldg.	Ottumwa, Ia.
266	3	Ammonia pipe exploded			Hotel Belmont	Hotel	New York, N. Y.
267	3	Boiler exploded	2	1	West Chazy Granite Co.	Stone Works	West Chazy, N. Y.
268	3	Heating boiler exploded			York Street School	School	Brooklyn, N. Y.
269	3	Two headers cracked			Galveston Electric Co.	Power Plant	Galveston, Tex.
270	4	Flange on main steam line cracked			McKeefrey Iron Co.	Blast Furnace	Leetonia, O.
271	5	Head of offal tank ruptured			Retail Butchers' Protective Asso.	Abattoirs	Cleveland, O.
272	5	C. I. headers of power boiler cracked			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.
273	5	Section of heating boiler cracked			Framingham Hospital	Hospital	Fram'gham, Mass.
274	5	Section of heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Glens Falls, N. Y.
275	6	Tube ruptured			Michigan Carton Co.	Paper Mill	Battle Cr'k, Mich.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1923

Capital Stock, . . $2,000,000.00

ASSETS

Cash in offices and banks		$532,313.26
Real Estate		255,000.00
Mortgage and collateral loans		1,797,550.00
Bonds and stocks		7,170,021.35
Premiums in course of collection		886,034.35
Interest Accrued		125,956.83
Total assets		$10,766,875.79

LIABILITIES

Recerve for unearned premiums		$4,979,417.54
Reserve for losses		311,286.82
Reserve for taxes and other contingencies		423,444.37
Capital stock	$2,000,000.00	
Surplus over all liabilities	3,052,727.06	
Surplus to Policy-holders		**$5,052,727.06**
Total liabilities		$10,766,875.79

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President and General Counsel.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Directors, United States Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O ENDERS, President, United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BUCKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.
SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, Vice-President, Hartford Electric Light Co., Hartford, Conn.

Incorporated 1861.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLY-WHEEL EXPLOSIONS AND ENGINE BREAKAGE

Department	Representatives
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, MD., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, Ct., 405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. E. Mason Parry, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'l'v'd	J. F. Criswell, Manager. P. M. Murray, Ass't Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	A. Paul Graham, Manager. L. T. Gregg, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J. H. Chestnutt, Manager and Chief Inspector.
HARTFORD, CONN., 56 Prospect St.	F. H. Kenyon, General Agent. E. Mason Parry, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., 80 Maiden Lane	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnett, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickham, Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrot Bldg.	Geo. S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	McCargar, Bates & Lively, Gen'l Agents. C. B. Paddock, Chief Inspector.
SEATTLE, Wash., 301 Thompson Bldg.	C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B Warner,. Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, President. The Boiler Inspection and Insurance Company of Canada

THE HARTFORD LINE

BOILER INSURANCE

Boilers, Economizers, Vulcanizers, Kiers, Digesters, Steam Driers, Jacketed Kettles, Etc.

FLYWHEEL INSURANCE

Flywheels, Fans, Blowers, Turbines, Water Wheels, Centrifugal Driers, Gear Wheels, Etc.

ENGINE INSURANCE

Engines, Compressors, Pumps, Refrigerating Machines, Etc.

ELECTRICAL MACHINERY INSURANCE

Generators, Motors, Synchronous Convertors, Transformers, Switchboards, Etc.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER
INSPECTION and INSURANCE CO.
HARTFORD CONNECTICUT

"The *oldest* in the Country, the *largest* in the world"

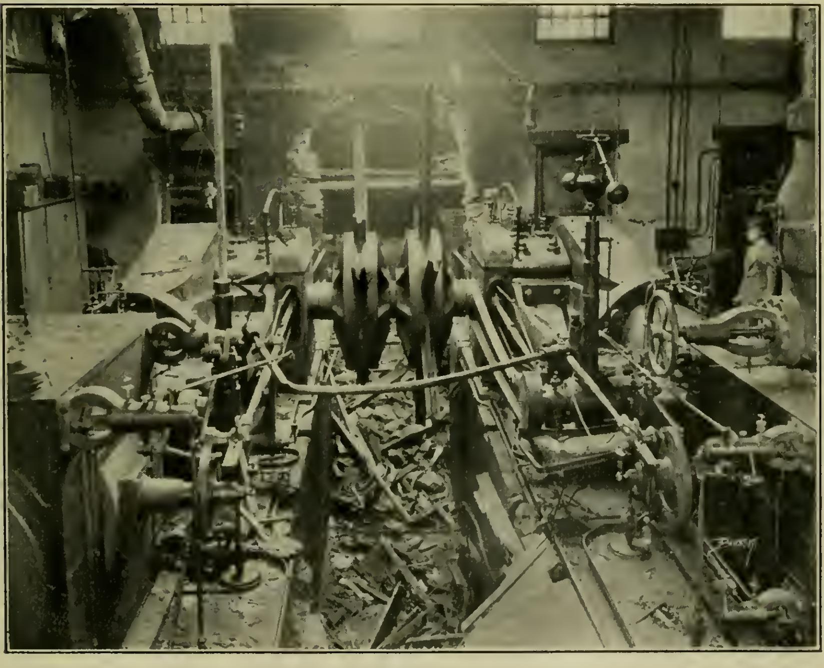
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIV. HARTFORD, CONN., JULY, 1923. No. 7.

COPYRIGHT, 1923, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



FLYWHEEL EXPLOSION AT A FIBRE MILL.

A Fly-Wheel Accident at Bridgeport, Pa.

While it is fortunate that fly-wheel explosions are not so numerous as boiler accidents, yet it must be remembered nevertheless, that when they do take place the damage done to the engine of which they are a part and the surrounding property is frequently extensive and costly both of life and property. The picture on the front page of this issue of THE LOCOMOTIVE shows in striking manner the havoc wrought in the plant of the Diamond State Fibre Co., at Bridgeport, Pennsylvania, by the explosion of a fly-wheel. This accident occurred between 6 and 7 P. M. on December 23, 1922. The fly-wheel really consisted of two wheels, each 20 ft. in diameter, bolted together with a total width of 60 inches. The wheels, which were attached to a cross compound engine having 24 inch and 48 inch cylinders and a 46 inch stroke, were operated at 83 R. P. M. The engine was built in 1898 and was rated at 1000 H. P. with a normal load of 700 H. P.

It is stated that a short time before the accident occurred the engineer on duty noticed that the engine varied in speed and went to the beater room to see what change in load might be responsible for this fluctuation. Finding nothing unusual there he returned to the engine room and then noticed that the engine had speeded up so that it was dangerous to go near it. He had barely time to warn the other members of the operating force away before the wheel let go with a terrific crash which wrecked the roof of the building and threw sections of the fly-wheel weighing between one and two tons a distance of over 300 feet. A new paper machine was directly in line with the path of one of the largest flying pieces but fortunately it escaped damage although it was missed by only a few inches.

The cause of the accident seems to have been due to the failure of the governor to act because the oil, which was applied in ample quantity, did not reach the proper spot to adequately lubricate the sleeve on the governor spindle. As a result of this the sleeve stuck, the engine speeded up and the fly-wheel burst.

The damage was stated to be about $20,000, which fortunately was covered by insurance.

Electrical Insurance.*

KENNETH A. REED, Electrical Engineer.

Electrical Machinery Insurance, although relatively new in America is not new in foreign countries, especially in England. There it has been conducted for the past eighteen years, and the annual premium receipts for it exceed those for boiler insurance. While the actual launching of the line in this country was only recently brought about, the need for it was felt several years ago through inquiries of our assured for a complete coverage of their power plant equipment; and through requests for coverage on motors in plants which had changed from steam to electric drive, where for many years we had covered the boilers, engines and main steam pipes. In other instances our assured inquired why we stopped at an imaginary line between the fly-wheel and the generator, a pump and its driving motor, or a group of pulleys and the motor driving them. Some consideration was given these demands for electrical coverage several years ago, but the project had to be abandoned on account of the war. The study was resumed, however, in 1921 and the present form of insurance was launched at the beginning of this year.

Boiler insurance, which was originated in this country by The Hartford Steam Boiler Inspection and Insurance Company in 1866, is the best known form of power plant coverage. By gradual steps it has been extended to all classes of pressure vessels, including main steam lines. Insurance for fly-wheels and steam engines logically followed it. Thus up to this point entire power plant equipment, except the electrical apparatus, was protected against loss from explosion or breakdown. Doubtless you are familiar with such coverage, and the fact that the thoroughness of inspections, conducted by specialists in their line, is in a large measure responsible for the success of boiler and engine insurance. When our Company decided to place electrical insurance on the market it did so in the light of the demonstrated value of inspections, as reflected in the experience of fifty-six years, with the conviction that similar service would be equally successful in the protection of electrical machinery and that service of the same quality as heretofore given must be rendered. In order to render such service it was clear that this class of work would have to be handled with an organization of thoroughly trained men having broad electrical experience. In other words an entirely separate organization from the mechanical engineers who have handled our other lines would be required, and with this in view our electrical organization has been built up. Since I am a HARTFORD man and not altogether familiar with the way in which this business is handled by other companies, I am forced to point out such benefits as accrue from the HARTFORD methods. I trust, therefore, that you will pardon me for dwelling almost exclusively on my Company's methods of affording this protection.

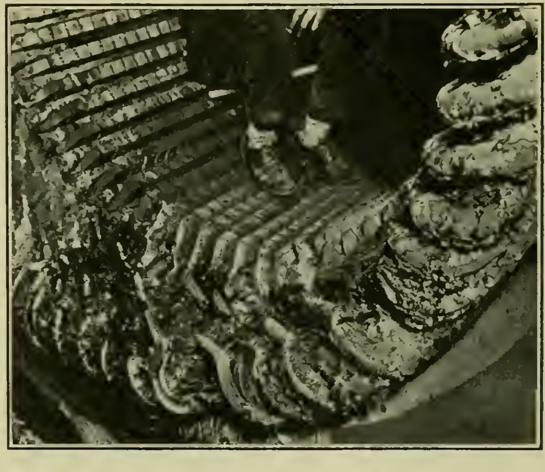
---

* *A paper read before the New England Association of Power Engineers and Power Sales Bureau of the National Electric Light Association, New England Division, at Boston, Mass., Dec. 6, 1922.*

Electrical machinery insurance differs in many ways from the other forms of casualty insurance handled by this Company, and especially so with reference to the damage which may be caused by a failure. In the case of a boiler or fly-wheel explosion the damage to the object itself is relatively small as compared with the damage to other property and the loss of life which may result, and therefore the value of the object insured has very little to do with the making of rates. In the case of electrical machinery, however, the damage in practically all instances is confined to the machine itself. Boiler insurance and fly-wheel insurance protect primarily against the castrophe hazard, and in a very large number of cases personal liability is involved; hence the rates and limits are based on damage which may be done to property aside from the boiler or fly-wheel itself. On the other hand damage resulting from the failure of an engine or a piece of electrical apparatus is in almost every case confined to the machine itself, and consequently the rates and limits for such coverage are affected by the value of the object itself and the policy has been drawn with this idea in view.

Electrical insurance is intended to cover any accidental breakdown or burnout of an electrical machine from any accidental cause while in operation or connected up ready for operation. Quoting from the standard electrical machinery insurance policy, a breakdown shall mean only a sudden, substantial and accidental burning out or breaking of a machine, or any part thereof, while the machine is in use, or installed and connected ready for use, which immediately stops the functions of the machine and which necessitates repair or replacement before its functions can be restored. From this definition it will be observed that the contingency must be sudden, substantial and accidental enough to stop the functions of the machine and prevent its further operation, but when those conditions are satisfied then an accident has occurred, and it is immaterial whether the damage be the result of carelessness, improper operation, lightning, or other accidental causes. The necessity for the requirement that the accidental burnout must be so sudden and substantial as to prevent the further operation of the machine is obvious, since mere repairs, such as worn bearings, worn commutators and collector rings, worn brushes, blown fuses, frayed insulation and other things of similar nature are not accidents, but are expected wear and tear, and consequently should be looked upon as a part of the maintenance and upkeep of the equipment. The policy contemplates protecting against accidental failure and does not cover maintenance in any respect. Gradual depreciation which is discovered, either by the assured or ourselves, before a failure, is not an accident inasmuch as the requirement that a failure must be sudden, substantial and accidental, has not been fulfilled.

Broadly speaking, under this insurance all classes of rotating and non-rotating apparatus, including switchboards, starters, power cables, etc., which are subjected to accidental and unanticipated failures, may be protected and only a few objects such as electric lamps, heating elements, lifting magnets, lightning arresters, magnetic chucks, storage batteries, vacuum tubes, etc., which are considered as uninsurable hazards, are excluded.



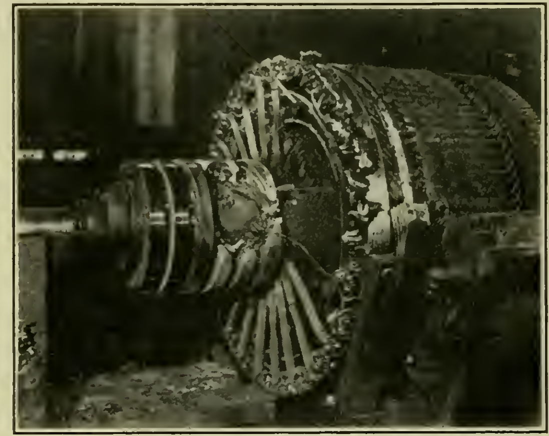
Burnout of the Stator Winding in a Large Turbo-Generator.

The policy provisions have been only briefly touched upon because of a lack of time and also because I want to interest you in what I believe to be the most important part of this insurance, namely, the inspection service. Following our past practice, which has proved so successful, each and every object is very carefully examined both while in operation and at rest. While in operation our electrical inspector makes observation of such points as the proper method of drive, proper foundation, the question of vibration, exposure to dampness, location of the machine with reference to the probability of damage from outside sources. He also checks the voltage at the machine terminals, notes whether the oil rings are properly carrying oil to the bearings, checks the speed, and observes other points which might affect the installation or operation of the apparatus. When the object is at rest he takes Megger readings of the windings, checks the air gap, examines the bearings, notes the condition and depth of stock in the commutator or collector rings, observes the condition of the insulation, examines the protective equipment and notes the settings of the relays and circuit breakers, or the size of fuses, examines the coupling, notes the condition of the brushes and brush rigging, checks up the quality of the lubricating oil, notes provisions for putting out fire, takes the temperature of the hottest part of the machine if it appears abnormal, observes whether or not the field of a synchronous motor is properly equipped with a discharge resistance, notes the over speed devices and reverse current relays, checks the assured's station voltmeter with one of our portable standards, and inquires into the history of the object. If the characteristics of an object have been changed he checks up the connections to see if the work has been properly done, and the correctness of such re-connections is determined before we take the risk. This point is of particular value when an assured is buying secondhand equipment.

While most of the above remarks apply to rotating apparatus, our inspection of transformers, switchboards, starters, cables, etc., is no less thorough. With special reference to transformers, Megger readings are taken between the high tension winding and ground, low tension winding and ground, and the high tension and low tension windings, since such readings indicate in a measure the condition of the windings. The level and quality of the oil are also observed, and if the assured does not have the oil tested at regular intervals we take samples and have breakdown tests made. All of the high and low tension terminals are examined to see that the clamping nuts are set up tight and note is made of the condition of the terminal boards relative to an accumulation of sediment or possibly foreign matter. Special attention is given to the cooling coils of water cooled transformers and the question of warning in case of a stoppage of water or excessive temperature is looked into. Account is taken of the location of transformers, and whether or not proper facilities are provided for conducting the oil to a sewer or some other place which will prevent additional damage should an explosion or fire occur. The tanks are examined for leaks, as well as to determine their general condition, and both the kind of protective devices and their setting receive special attention. A transformer inspection where either the incoming or outgoing leads are on poles is, of course, incomplete without an examination of the lightning protection and the determination of whether or not a good ground has been provided.

For all classes of electrical apparatus the main leads and control wires are inspected both for capacity and safety of installation, and we, of course, note in cases of alternating current apparatus whether the leads are all run in the same or separate iron pipes.

In practically all cases our electrical inspector is accompanied by one of the assured's men throughout the examination of the electrical apparatus, and before leaving the plant the electrical inspector confers with the superintendent or other responsible man in charge and informs him verbally of the conditions as found. After each of our first and subsequent inspections a detailed report giving the exact condition of each and every object examined is forwarded to the assured. This report also embodies our suggestions relative to machines which are acceptable but require attention, and discusses such objects as we are unable to accept in their condition as found, pointing out what should be done to these objects in order to make them acceptable for insurance. The receipt of such a periodical report gives great satisfaction to the user of electrical apparatus in that he is able to know definitely the condition of his equipment, whether it is satisfactory or requires attention.



Armature Burnout of Rotary Convertor.

While this business is new and doubtless will improve with time, sufficient experience has already been had by this Company to demonstrate, in a measure, the value of our inspection service. That is to say, we have rendered such service to our assured, in the way of preventing accidents and improving operating conditions as to demonstrate the efficacy of our work, and I shall endeavor, by citing actual cases, to illustrate some of the advantages which our assured derive from inspection service.

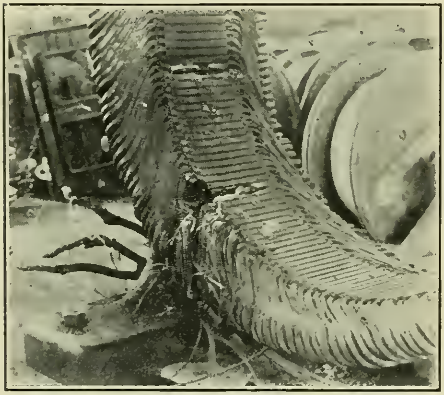
In a large majority of cases our examination of the windings of rotating equipment shows a considerable accumulation of oil and dirt, or other foreign matter which causes rapid deterioration of the insulation, and we, therefore, make such recommendations as are necessary in order to place the windings in first class condition and keep them so. It might be pertinent to mention at this time that an editorial in the October 10th, 1922 issue of *Power* comments at some length on the returns which have been received from a questionnaire sent out by the *Association of Iron and Steel Electrical Engineers* to a number of the largest steel plants, asking for information on motor failures. The data obtained show that 30% of the alternating current motor failures and 41% of the direct current motor failures can be attributed to excess oil on the insulation.

We have located a large number of cases of rotor trouble in squirrel cage motors, thereby preventing the burning out of the stator windings, and reducing the time that the motors were out of service. In a number of instances the primary terminals of power transformers, supplying the total energy to industrial plants, have been found loose, requiring several turns of the clamping nuts to draw them up tight. Had this trouble not been located, in all probability serious damage would have resulted to the transformers thereby temporarily shutting down the entire plant. Many instances may be shown where polyphase motors were found running single phase, and our inspection service discovered the trouble in time to prevent burnouts. Linseed oil has been found in motor bearings and in a few cases we have discovered lubricating oil in transformers. In one instance in cold weather the oil had become so thick that it had practically congealed. Fortunately the transformer was not fully loaded and the condition was discovered before trouble developed. Incorrect, as well as worn out oil exists in many starters and circuit breakers, and by pointing out this condition to the assured, a burnout may be prevented.

By taking Megger readings we discover a large number of cases where the windings are in very poor condition, and by having such machines taken care of immediately the windings are saved In all probability we have prevented more failures by taking insulation resistance readings than by all other means of locating trouble combined. In one plant which generates a portion of its power and purchases the balance, we found a dead ground in the winding of a 1000 k. v. a. generator. This information was imparted to the manager who decided that due to a lack of power it would be necessary to operate the machine, even though he would do so on his own responsibility. The generator burned out the following morning.

Breakdown of a High Voltage Potential Transformer.

The prevention of a burnout has a far more reaching effect than the mere avoidance of a failure insofar as the owner of the machine is concerned, for a burnout to him means the loss of time of a number of men for at least as long as it will take to install a spare motor, if one be available, or at best several hours time may be wasted before the men can be rearranged for other duties. Therefore while our insurance would reimburse him for the damage caused by the failure, our inspection service renders him a much greater service by preventing the accident. Accordingly the prime object of our inspection service is to prevent accidents and one of the things which we have found most necessary is the educating of the users of electrical apparatus as to the proper way in which to care for and operate their equipment. Such instructions are almost invaluable to the user who has only a small number of motors, and consequently cannot afford to employ an experienced electrician; or to the industry which has changed from engine and line shaft drive to motor drive, at the same time placing the man-of-all-work, who has grown up with the institution, in charge of the electrical equipment. As an example the case is often cited where two industrial plants changed from steam to electric drive at the same time. The electrical equipment of one of the plants was placed in charge of an experienced electrical engineer, while that of the other was looked after by the same man who had taken care of the steam drive for many years. At the end of a year the former plant was in first class condition while the owners of the latter plant were almost ready to return to the original method of drive. The advice and instructions of our electrical inspectors would have enabled the second plant to attain the same standard of efficiency developed at the first plant; and electrical insurance would have made it possible for both plants to definitely figure their maintenance and depreciation for the following year.



Burnout of Armature of Rotary Convertor.

The assistance given to our assured is not limited to pointing out trouble and suggesting remedies for existing conditions but is extended in many other ways. On one occasion an electrical inspector, while investigating a burnout at a foundry, turned to and assisted the assured in the installation of a spare motor so that a heat might be taken off without delay. On another occasion an exciter had burned out, and in order to get the plant going at once an electrical inspector made use of a pair of spare telephone wires and some old rheostats to transmit exciting current of double the normal voltage from a power circuit a considerable distance away.

One of our assured had a 300 h. p. 2200 volt induction motor located in a brick yard, and at the time of our first inspection the motor was inadequately protected against lightning. Recommendations were made in the field for immediate installation of such protection but this advice was not followed, and as a result 36 coils were lost through a stroke of lightning. This motor was the main drive for the brick yard and was out of service for three or four days while undergoing repairs. While making an inspection at a textile mill one of the shunt field leads of a 15 h. p. motor was loose and vibrating, which caused improper operation of the motor, and had the lead fallen out of its terminal entirely while the motor was in operation there undoubtedly would have been a runaway resulting in a bad wreck. Just before completing a day's work in a department store, one of our electrical inspectors found the commutator necks of a d. c. machine so heavily coated with dirt and carbon and copper dust that he advised the assured the machine was dangerous to operate. In the same room he inspected an additional machine which showed that commutator trouble might be expected at any instant. Ten minutes after he left the building the commutator of the second machine suffered a failure, and during the night the first machine emitted a large volume of smoke, resulting from short circuits between the risers. A case worthy of special mention was found in a cotton mill where a number of 150 h. p. motors had burned out with no apparent cause. Our inspection disclosed the fact that one of the blades of the oil switch feeding this circuit from a bank of transformers slipped down on the pull rod to such an extent that poor contact was made on first closing the switch and later vibration would cause this phase of the switch to open altogether, thereby bringing about single phase operation of the motors. In other instances the rotating members of electrical machines have been balanced, grounds have been located on the iron framework of elevators, and our men are ready to turn a hand whenever they can be of assistance to our assured.

Failure of Large Turbo-Generator.

The above cases have been selected from our experience in an effort to show the variety of dangerous conditions which we find and I believe that by helping industrial plants to keep their equipment in satisfactory running condition there will be fewer complaints to the central stations, and more satisfied customers.

From the HARTFORD'S point of view the new line has already developed popularity equal to the Company's anticipations and I believe that the following partial list of industries, which we have insured and which are served by New England Central Stations, will show to some extent the enthusiasm which has been aroused: —

Automobile Manufacturers and Dealers
Brick Manufacturers
Clothing Manufacturers
Construction Companies
Dairies
Dyeing and Cleaning Concerns
Electrical Fixture Manufacturers
Fireworks Manufacturers
Foundries
Gas Plants
Hardware Manufacturers
Hotels and Restaurants
Hospitals
Ice Cream Factories
Laundries
Lime Products Companies
Paper Mills
Printing Companies, including binders and engravers
Public Buildings, including office buildings, Y. M. C. A. buildings, churches, etc.
Shoe Manufacturers
Tanneries
Textile Industries, including bleacheries, silk, woolen and cotton mills, carpet, thread, card-cloth and shoe-lace manufacturers
Woodworking Companies, including box factories.

At the N. E. L. A. convention in Atlantic City last spring there seemed to be a feeling among some of the members that considerable expenditures would have to be made by the assured in the way of providing the latest type of protective devices, placing the machines in practically new condition, wiring up the objects in a particular manner, etc. in order that the electrical apparatus be acceptable to the Insurance Companies. In other words every object would have to be just so or it would not be accepted for coverage. Speaking for our Company I wish to correct any such impressions as these which may have been given credence. We do, as previously stated, inspect every object before it is accepted and if the machine is safe no other requirements are necessary. Should we find obsolete methods of protection, such as string fuses or a poor job of wiring (which does not endanger the object itself) we call attention to such points and recommend that cartridge fuses be installed or that the wiring be done in accordance with the Underwriters' Code; but we do not hold such recommendations obligatory in order that the objects be acceptable for insurance.

On the other hand if we find such conditions as the insulation resistance of the winding of a machine so low as to approach a ground, the insulation itself badly damaged, the bearings so badly worn that the rotor is almost rubbing on the stator or the oil in a transformer containing so much moisture that it will break down at 6000 to 8000 volts or less, then I believe you will agree with me that we are justified in withholding coverage until such conditions are remedied. In many instances the assured is not aware of the existence of things of this nature and he is highly pleased to have them pointed out to him in time to prevent a failure.

A slight misconception of Electrical Machinery Insurance is held by the plant electrician. His first idea is that the electrical inspector is "butting in" and is coming around with a chip on his shoulder looking for ways of "showing the electrician up." However, after the electrician has gone around with the electrical inspector for awhile, or some one who is familiar with this form of insurance has explained it to him, he learns that he has met a friend and extends his hearty co-operation. There, too, is a splendid opportunity for close co-operation between the Central Stations and the Insurance Companies in connection with this new line of underwriting, and we wish to assure you that instead of feeling that your interests and our interests are divergent, we feel that the interests of both are identical in that both are striving to render service to the users of electrical apparatus.

There may arise instances where it would seem that our recommendations are at variance with the standard practice of Central Stations, but such cases are entirely unintentional insofar as any criticism on our part is concerned. As illustrating this point, we were recently offered a single motor for coverage and we found that lightning had burned out the motor on two occasions, in a relatively short time, and naturally we recommended that lightning arresters be installed. Shortly thereafter the Power Company wrote us that it was not their usual practice to equip individual motor installations with lightning protection and they felt that we were criticising their secondary distribution system as being improperly protected. We, of course, hastened to inform the Power Company that no criticism was intended and after stating the facts in the case, as well as the reasons for our recommendation, the position of our Company was made clear and the matter disposed of to the satisfaction of both parties.

Your companies are deeply interested in making the use of electrical apparatus popular with both existing and prospective customers, and anything which will contribute to this end will be of value and assistance to you. Electrical Insurance will relieve your customer of unexpected losses caused by unforeseen failures, while its inspection service will assist him in keeping his apparatus in condition. Accordingly, this new line of underwriting should and will tend to make simpler and easier the operation of electrical machinery and thus contribute to the popularity of the use of electrical power in general and to the satisfaction of the customers of your central stations in particular.

A Novel Method of Removing a Concrete Stack.

By Resident Agent L. L. Coates.

THE building of a tall stack of any material involves considerable engineering skill and careful workmanship. The removal of such a stack also demands careful study in order to accomplish the work in a safe, economical and speedy manner.

The Newaygo Portland Cement Co. of Newaygo, Mich. was recently confronted with the necessity of removing one of two twin stacks of reinforced concrete, shown in Figure 1, and the method used to accomplish this removal appeals to us as both novel and interesting. As the stack was 153 feet high and 14 teet in diameter at the base, it was apparently going to be an expensive proposition to bring it down. The management of the cement plant consulted with several stack engineers as to the best manner of removing the obstacle. None of them was anxious to undertake the job, and the nearest to definite advice that the cement company was able to get as to the manner of removal was a suggestion that they build up a scaffold on the inside and to the top of the stack and then chisel the concrete to pieces bit by bit.

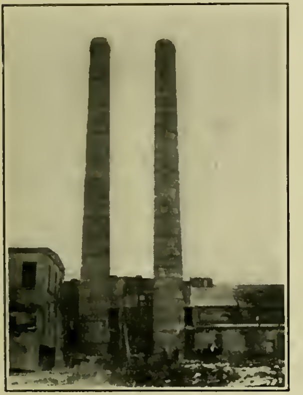


Figure 1.

This procedure would have been both slow and expensive and therefore did not appeal to Superintendent L. E. Smith, so he, on his own initiative, worked out a plan by which he succeeded in felling the stack within one foot of the desired line on the ground. As his method was quick, economical and altogether practical, it is described below for the benefit of others who may face a similar problem. The method used was that of felling the stack by dynamite, and was carried out in the following manner.

In a section four and a half feet high at the base of the stack and extending half around its circumference on the side away from the building, holes were drilled from three to four inches deep and the outer surface of this section was removed by exploding small charges of dynamite in these holes. The reinforcement rods exposed by this means were then cut by a gas torch and removed.

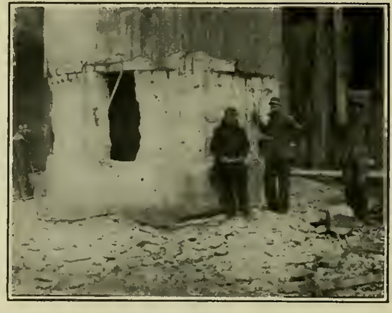


Figure 2.

The next step was to make a hole through to the inside of the stack, by blowing out a section about twelve inches wide and four and a half feet high as shown in Figure 2. Since the wall was eighteen inches thick at the base, this part of the work required considerable time and care.

Sections on each side of this opening were next removed by drilling ¾ inch holes at irregular intervals one or two feet apart and exploding small charges of dynamite in these holes so that by each explosion a section was removed extending from the drilled hole to the opening through the base. This procedure was repeated several times until the opening extended nearly half around the stack.

A gash was then chiseled out of the stack on the side opposite the opening, and eleven of the vertical reinforcement rods were burned off to offer less resistance when the stack should start to fall and also to help define the direction of the fall.

The opening in the front of the stack was then gradually widened with the use of larger quantities of dynamite. When the opening was increased to slightly more than one half the distance around the base, the stack was observed to vibrate like a massive pendulum, its top actually swinging a distance of eighteen inches or more and coming to rest at an inclination about ten inches out of perpendicular. After one more charge was exploded on each side of the opening in the base, the stack promptly fell into the designated position on the ground and was reduced to a mass of shattered concrete and steel. Although originally fourteen feet in diameter, the stack, when it fell, made a mound only three or four feet high as will be seen in Figure 3.

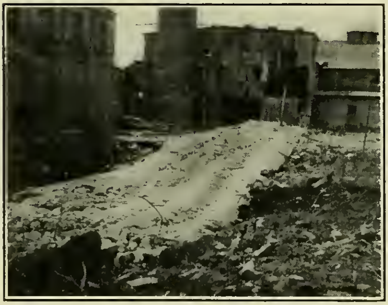


Figure 3.

The actual felling occurred on New Year's morning and was witnessed by a large number of interested spectators.

The entire cost of felling the stack was $40.73, which amount was composed of the following items: dynamite $2.19, caps $5.39, labor $33.15. The company carried out this work with its own employees, and was fortunate in having one man who was an expert dynamite "shooter."

The Story of Mr. Herringbone and Mr. Clinker.

By Inspector T. F. Connery

Characters: *Mr. Herringbone* — A grate much too hot above the shoulders; *Mr. Clinker* — A nuisance much hotter all over his body.

Time: The Present.

Place: A Neglected Boiler Furnace.

Mr. Herringbone: Look out up there, mush, you are shutting my wind off. You have at least six of my ribs plastered together now. I fear my lungs will burst for the want of air.

Mr. Clinker: I beg your pardon, sir, I did not mean to cause you any annoyance, but the fellow on the outside insists on prodding me with something so I am only trying to protect myself by spreading out and not being so conspicuous.

Mr. Herringbone: Well I hope neither of you indulge too long in your tit for tat because my back is getting so hot I fear my spinal column will give away and we'll all land in a mass in the ash pit.

Mr. Clinker: You frighten me, sir, I was not aware I was doing you so much injury.

Mr. Herringbone: You are not only injuring me, sir, but you are raising the dickens with the CO_2, causing him to fly up the flue.

Mr. Clinker: The CO_2, pray tell me something about him. I was not aware of his presence. I thought we were in here comparatively alone.

Mr. Herringbone: I am surprised that you have not learned of the CO_2, although I must confess that until recent years, not very many knew much about him. Chemists, of course, knew and some efficiency fellows.

Mr. Clinker: Well, tell me how this CO_2 is so well known now.

Mr. Herringbone: Through the Correspondence Course in Combustion by The Hartford Steam Boiler Inspection and Insurance Co.

Mr. Clinker: What kind of a course is that?

Mr. Herringbone: Oh, one where they just get down to brass tacks.

Mr. Clinker: Can't see the brass tack connection.

Mr. Herringbone: Now, Clink, don't get too literal. The Hartford not only tells the fellow with the strong back about the CO_2 and the B. T. U., but a lot about hoes, rakes, slice bars, etc. and also about the hearse you are to take a ride in when you get out of here, namely, a wheelbarrow with an iron body so that you do not set fire to the boiler room.

Mr. Clinker: Say, Herringbone, I am getting to feel kind of sick at the stomach.

Mr. Herringbone: Watch yourself, old fellow, that's the CO that is giving you the funny feeling.

Mr. Clinker: How many individuals in here, anyway?

Mr. Herringbone: Quite a number, but the CO is a death dealing fellow. I know a couple of boiler inspectors he almost killed in a combustion chamber.

Mr. Clinker: I surely seem to be in bad. What is all that racket I hear on the outside?

Mr. Herringbone: The Chief Engineer has just come into the boiler room, slamming the door behind him. He is now telling the Fireman that the steam is too low to haul the load, and that he suspects your presence in here.

Mr. Clinker: Well, if that's the case, no doubt, we will soon part.

Mr. Herringbone: Sorry to say that I am not quite sure we'll entirely part for I feel as if you had taken a piece out of my back.

Considerable agitation in the ash pit.

Mr. Clinker: Say Herringbone, are you spitting on me?

Mr. Herringbone: No, but the Chief has turned the hose in the ash pit and something dreadful is going to happen to you.

Mr. Clinker: I feel something sliding under me now. Is that the slice bar you mentioned about?

Mr. Herringbone: Must be, sir, for the Chief has got busy. He is a Hartford combustion course graduate.

Mr. Clinker: I wish now that the Fireman had been, as I would not have become so large and, consequently, I would not be subject to such roughness as I now suffer.

Mr. Herringbone: Yes, I think you are in for a rough time, old boy, so I will say good-bye, as I find the use of the hose and the slice bar have entirely removed you from my back. I have a pleasant vision of the future as I hear the Chief telling the Fireman that he must take the Combustion Course given by The Hartford.

Moral: Let all who want to know about Combustion do the same.

A New Method of Rating Moving Picture Stars.

COAL-BURNING theatre managers on Broadway were interested yesterday in the news from Boston about Professor Miller. It seems Prof. Edward F. Miller of the Massachusetts Institute of Technology has discovered that the average person, when calm, gives off 425 heat units, but when emotionally excited the heat units jump to — oh, thousands and thousands and thousands.

Professor Miller found it out by observing audiences in theatres. He found that the added heat generated by the audience at the plays' crucial moments raised the temperature of the theatre several degrees.

Naturally, the coal-burning managers were interested. Al. H. Wood was gleeful.

"I wondered," he exclaimed, "what was keeping my coal bills down."

It was estimated on figures gathered from the Professor's idea, that the Misses Florence Reed, Violet Heming, Ina Claire, Pola Negri, Theda Bara and Lenore Ulric save the Messrs. David Belasco, Arthur Hopkins, Mack Sennett and Charles B. Dillingham upward of $547,687 yearly in anthracite coal bills alone, not including the bituminous.

In fact it was said at the Lambs' Club last night that these young ladies had received a petition from the starving miners in Pennsylvania, requesting them to act cold during the remainder of the winter.

The report also went that Mrs. Leslie Carter plans to file suit for a rebate on 465,876 tons of coal she is alleged to have saved David Belasco in "Du Barry" and "The Heart of Maryland."

A kiss by John Barrymore saves a theatre a ton of chestnut or a ton and a half of egg coal, was the opinion of one prominent actor, standing at Broadway and 42nd Street yesterday.

The Professor's discovery has created quite a stir on Broadway. Hereafter, actors and actresses who have reputations as warm babies, may demand a coal-saving clause in their contracts.

— *New York World.*

The Locomotive

DEVOTED TO POWER PLANT PROTECTION
PUBLISHED QUARTERLY

WM. D. HALSEY, Editor. C. L. WRIGHT, Assistant Editor.

HARTFORD, JULY, 1923.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

Obituary.

Joseph Hensley McNeill.

THE sudden death of Joseph Hensley McNeill on April 18th, 1923, terminated a career of conspicuous service in safeguarding the use of steam power. From the time of his appointment to the boiler inspection force of the District Police of the Commonwealth of Massachusetts in 1898, his thoughts and energies were devoted to this one purpose. When ten years later Massachusetts determined by law that public safety in that state required standards of boiler construction and of steam operation, he was chosen its chief inspector, and later chairman of its Board of Boiler Rules, because of his eminent fitness for those positions. In them he had a prominent part in formulating the Boiler Code of Massachusetts, a code which became the basis and foundation of the regulatory measures adopted in recent years by many other states and municipalities.

Joseph Hensley McNeill.

In 1912 Mr. McNeill was persuaded to join our organization and there carry on in an even broader field the activities which he had made his life's work. As chief inspector of our New England Department for three years and afterwards, until his death, as chief inspector of our New York Department he continued to manifest that conscientious zeal and devotion to his purpose which characterized his whole life. He ably administered the work of those departments and in a manner which secured and retained the confidence and respect of the thousands of steam-users and boiler-owners with whom he came in contact. During this period, too, he continued an active interest in all efforts to establish by law safeguards against the dangers of steam operation. The benefit of his experience in Massachusetts and elsewhere he made freely available to those who had the formulation of laws or codes for this purpose. He was especially interested in this work in the State of New York and for a number of years was an active member of the Board of Examiners of the Boiler Inspection Department of that State.

He was a member of the American Society of Mechanical Engineers. He strongly advocated the adoption by it of its standard code of boiler construction which is now universally recognized throughout the country. To Mr. McNeill's influence on this code and on all efforts to safeguard the use of steam, the Boiler Code Committee of the American Society of Mechanical Engineers bears tribute in the following resolution adopted at its meeting of April 27th, 1923:

> "RESOLVED: That in the death of Joseph H. McNeill, the application of engineering knowledge and experience to the design, construction and operation of steam boilers has lost one of its foremost American advocates and administrators;
>
> "That, when this Committee took up the task assigned to it, we found in Mr. McNeill a pioneer worker in the field; and in the service which he had already accomplished for the Commonwealth of Massachusetts a precedent which has been of great value in our own work;
>
> "That, in our contact with him we have found him a competent engineer, a conscientious official, a staunch and true friend and a genial, lovable companion;
>
> "That, we sympathize with those still more closely bound to him by ties of kinship and affection, and direct that a copy of this resolution be conveyed to his family and spread in full upon the records."

Mr. McNeill's earnest and sincere character was ever in evidence. His frank and engaging personality attracted the regard and respect of new acquaintances and to his friends his courteous consideration and geniality made him a loved companion. Many men in all walks of life will share with his associates of The Hartford Steam Boiler Inspection & Insurance Company the sorrow which his death brings to them and will recognize the loss which it means to our Company.

Personal.

Mr. E. Mason Parry has been appointed Chief Inspector of the New York Branch of this Company to fill the vacancy caused by the death of Joseph H. McNeill.

Mr. Parry was educated in England and served an apprenticeship with Harland & Wolff, Shipbuilders and Enginers. He later entered the Merchant Marine service in which work he continued for nine and one-half years, holding a first class engineer's license.

In 1906 he entered the employ of The Hartford Steam Boiler Inspection and Insurance Company as an inspector in the Boston office. In 1913 he was transferred to the Home Office of the Company at Hartford as Directing Inspector, and in 1918 he was appointed Chief Inspector of the Hartford Department to succeed the late Frank S. Allen.

Mr. Parry is a member of the American Society of Mechanical Engineers and the Society of Naval Architects and Marine Engineers.

The transfer of Chief Inspector E. Mason Parry from the Hartford Department to the New York Department created a vacancy in the former which has been filled by the advancement of Mr. A. E. Bonnet, Assistant Chief Inspector at New York.

Mr. Bonnet was educated at Greenwich Academy and Stevens Institute. After three years' service in stationary engineering practice, he entered the Merchant Marine service, which he followed for five years. He then entered the United States Revenue Cutter Service as Lieutenant of Engineers, serving three years, part of the time in Alaskan waters.

In 1904 he entered the employ of the Hartford Steam Boiler Inspection and Insurance Company as inspector in the New Orleans Department. In 1913 he was transferred to the New York office, and in 1915 he was made Assistant Chief Inspector of that department.

Mr. Robert P. Guy has been appointed Assistant Chief Inspector of the New York Branch of this company to fill the vacancy caused by the transfer of Mr. A. E. Bonnet.

Mr. Guy, who has had considerable experience in the operation of power plants, entered the employ of this company in 1910 as an inspector in the Hartford Department and in 1920 was transferred to New York, where, previous to his promotion, he was Directing Inspector.

Some Provider.

"Is your husband much of a provider, Milandy?"

"He jes' ain't nothin' else, ma'am. He gwine to git some new furniture providin' he gits de money; he gwine to git de money providin' he go to work; he go to work providin' de job suits him. I never see such a providin' man in all mah days."—*Exchange.*

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF APRIL, 1922

Continued from April, 1923 Issue

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
276	6	Tube of power boiler ruptured			Pine Bluff Co.	Lgt. & Water Wks.	Pine Bluff, Ark.
277	7	Boiler tube exploded			U. S. S. Gregory	Destroyer	Portsmouth, Va.
278	10	Tube of power boiler ruptured			Continental Trust Co.	Office Bldg.	Baltimore, Md.
279	10	Crown sheet of power boiler failed		2	Isaac N. Minor	Quarry	Little River, Cal.
280	10	Two tubes ruptured			Orinoka Mills	Textile Mill	Philadelphia, Pa.
281	11	Flue sheet cracked			United Light & Rys. Co.	Power Plant	Moline, Ill.
282	11	Steam heating boiler on car exploded		1	Ohio Electric Traction Co.	Interurban S'v'ce	Newark, Ohio
283	13	Fire sheet bulged and ruptured			Barcalo Mfg. Co.	Bed Factory	Buffalo, N. Y.
284	14	Fire sheet ruptured			Public Service Co. of Northern Ill.	Power Plant	Chillicothe, Ill.
285	14	Section of heating boiler cracked			H. C. Whitcomb & Co.	Wax Melting Plt.	Boston, Mass.
286	15	Section of heating boiler cracked			Atlantic Metal & Novelty Wks.	Novelty Mfg.	Newark, N. J.
287	15	Section of heating boiler cracked			Woodberry Forest School	School	W'db'y Forest, Va.
288	15	Section of heating boiler cracked			L. Needles-Brooker Co.	Shirt Factory	Philadelphia, Pa.
289	15	Section of heating boiler cracked			Board of Education	School	Pittsburgh, Pa.
290	15	Boiler exploded			Grant County Creamery	Creamery	Milbank, S. D.
291	17	Blow off pipe failed			Woodlawn Finishing Co.	Yarn Mills	Pawtucket, R. I.
292	19	Section of heating boiler cracked			Toledo Parlor Furniture Co.	Furniture Factory	Toledo, O.
293	19	Three sections of heating boiler cracked			McIntosh Brothers	Hotel	Las Animas, Colo.
294	19	Four ammonia tanks exploded		2	Tech. Food Products Co.	Ice Cream Plant	Pittsburgh, Pa.
295	21	Heating boiler exploded			Draper School	School	Rotterdam, N. Y.
296	21	Cast iron header of power boiler cracked			Agasoti Mill Board Co.	Power Plant	Trenton, N. J.
297	21	Two sections of heating boiler cracked			St. Joseph Catholic Church	Church	Calumet, Mich.
298	22	Boiler exploded			Hollman Ice Cream Co.	Ice Cream Plant	Hope, Ark.
299	22	Two sections of heating boiler cracked			L. V. Niles	Hotel	Boston, Mass.
300	23	Flange on 8" pipe burst			Sayles Finishing Plant	Textile Mills	Saylesville, R. I.
301	24	Section of heating boiler cracked			Hancock High School	School	Watertown, Mass.
302	24	Elbow of blow off pipe burst			J. M. Willis Lumber Co.	Saw Mill	Washington Court House, Ohio.

303	26	Fire sheet ruptured			Peoples Ice Co.	Ice Plant	Carthage, Mo.
304	26	Tube ruptured			Weirton Steel Co.	Steel Mills	Weirton, W. Va.
305	26	Boiler exploded		1	J. R. Higley	Saw Mill	Le Roy, O.
306	27	Crown sheet bulged and ruptured			Randall Lumber & Coal Co.	Saw Mill	Flint, Mich.
307	27	Four sections of heating boiler cracked			Pelham Health Inn	Hotel	New York, N. Y.
308	29	Mud drum exploded			Carnegie Steel Co.	Steel Mills	Munhall, Pa.
309	29	Tube of power boiler ruptured		1	Bryant Paper Co.	Paper Mill	Kalamazoo, Mich.
310	29	Boiler non-return valve burst			Middle West Utilities Co.	Power Plant	Newcastle, Ind.
311	29	Tube ruptured		2	Puget Sound Power & Lgt. Co.	Power Plant	Seattle, Wash.

MONTH OF MAY, 1922.

312	1	Tube ruptured			Woodward Iron Co.	Iron Works	Woodward, Ala.
313	1	Tube ruptured			Odd Fellows Hall	As'mbly Hall Bld.	Indianapolis, Ind.
314	1	Boiler exploded	1	2	Hook's Planing Mill	Planing Mill	Nacogdoches, Tex.
315	2	Tube ruptured			City of Canton	Water Works	Canton, Miss.
316	2	Fitting on main steam line ruptured			Boney-Harper Milling Co.	Grist Mill	Wilmington, N. C.
317	2	Boiler of locomotive exploded	3		Baltimore & Ohio R. R.	Railroad	Fairhope, Pa.
318	3	Fitting on 8" steam line failed			Marathon Paper Co.	Paper Mill	Rothschild, Wis.
319	4	Two sections of heating boiler cracked			H. P. Hood & Sons	Milk Station	Charlest'n, Mass.
320	5	Boiler exploded			Cassel, Cohen & Sons	Furriers	New York, N. Y.
321	6	Tube pulled out			Sisters of Charity	Hospital	Cincinnati, O.
322	6	Boiler exploded			R. E. Carroll	Saw Mill	Richhill, Pa.
323	7	Boiler sheet bulged		3	Los Angeles Brick Co.	Brick Works	Los Angeles, Cal.
324	8	Tee on 12" main steam line burst			William Scholes & Sons	Woolen Mills	Philadelphia, Pa.
325	9	Section of heating boiler cracked			New Orleans Country Club	Club House	New Orleans, La.
326	10	Tee on 12" main steam line burst			William Scholes & Sons	Woolen Mills	Philadelphia, Pa.
327	10	Boiler exploded	3	1	A. L. Evans	Saw Mill	Quitman, Ga.
328	13	Tube of down draft grate ruptured	2		Theo. W. Mertens	Ice Plant	St. Louis, Mo.
329	15	Blow off pipe failed			E. C. Lamm	Planing Mill	Danville, Ill.
330	15	Pipe fitting on line to engine cracked			Narragansett Mills	Cotton Mill	Fall River, Mass.
331	15	Section of heating boiler cracked			No. 2 West Sixty-seventh St.	Apartments	New York, N. Y.
332	16	Section of heating boiler cracked			Knott System Hotel	Hotel	Kew Gar., N. Y.
333	17	Blow off pipe failed			Francis F. L. Warner	Laundry	Oxford, O.
334	17	Boiler exploded		3	Long & Johnson	Saw Mill	Whitesburg, Md.
335	18	Tube failed			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
336	19	Section of heating boiler cracked			Est. Lucretia Mott Martin	Office Bldg.	Pittsburgh, Pa.

MONTH OF MAY, 1922 (Cont'd.)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
337	19	Tube failed			Davidson Biscuit Co.	Bakery	Mt. Vernon, Ill.
338	19	Automatic boiler cut-off valve ruptured			International Salt Co.	Salt Works	Ludlowville, N. Y.
339	19	Oxygen storage tank exploded	2	9	Harvard College	College	Cambridge, Mass.
340	19	Boiler valve burst		1	B. & O. R. R.	Railroad	Lima, O
341	22	Lug on section of heating boiler broke			J. & L. Strauss	Apartments	Louisville, Ky.
342	23	Header boiler cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
343	23	Boiler exploded		1	J. B. Heard	Rice Plantation	Orange, Tex.
344	23	Blow off pipe fitting failed			McLaurin-Jones Co.	Paper Mill	Brookfield, Mass.
345	26	Boiler exploded		3	Tugboat Libbie	Tugboat	New York, N. Y.
346	27	Superheater tube pulled out of header			Atlantic City Electric Co.	Power Plant	Atlantic City, N. J.
347	27	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
348	27	Hot water heating boiler exploded			Meek Restaurant	Restaurant	Peoria, Ill.
349	27	Tube ruptured			Nichols Copper Co.	Mfg. Plant	Laurel Hill, N. Y.
350	29	Boiler bagged			Houma Cypress Co.	Saw Mill	Houma, La.
351	30	Boiler exploded			Daniel Wetzel	Traction Engine	Buffaloville, Ind.
352	30	Boiler exploded	3	5	Brown-McEachin Lumber Co.	Lumber Mills	West Bay, Fla.
353	31	Tube ruptured			Union Lumber Co.	Lumber Mills	Union Mills, Wash.

MONTH OF JUNE, 1922.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
354	3	Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
355	3	Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Chrystal City, Mo.
356	3	Boiler exploded			Hosmer Farm	Oil Well	Olean, N. Y.
357	5	Tube ruptured		1	Drainage Commissioners	Pumping Station	New Holland, N.C.
358	6	Ammonia tank exploded			Herf & Frerichs Chemical Co.	Chemical Plant	St. Louis, Mo.
359	6	Crown sheet failed			White Eagle Oil & Refining Co.	Oil Refinery	Mexia, Texas
360	6	Header bulged			Kalispell Lumber Co.	Lumber Mill	Kalispell, Mont.
361	7	Boiler exploded			Atlanta Light & Power Co.	Power Plant	Lincoln, Ill.
362	7	Section of heating boiler cracked			Lisle I. Alport	Apartments	Springfield, Mass.
363	7	Two sections of heating boiler cracked			Toledo Parlor Furniture Co.	Furniture Factory	Toledo, O.

364	8	Two sections of heating boiler cracked			University of Pittsburg	Arts Hall	Pittsburgh, Pa.
365	9	Boiler exploded		1	William Elliott		Mansfield, Ill.
366	11	Manhole gasket blew out			Elite Laundry Co.	Laundry	El Paso, Tex.
367	12	Section of heating boiler cracked			James E. Mitchell	Commercial	New York, N. Y.
368	12	Boiler of locomotive exploded	2		Missouri Pacific R. R.	Railroad	Modoc, Ill.
369	12	Two sections of heating boiler cracked			R. C. Taylor Estate		Providence, R. I.
370	13	Boiler bulged and ruptured			S. P. Jackson	Cold Storage Plt.	Odessa, Mo.
371	13	Tube failed			Pine Bluff Co.	El. Lt. & W. W.	Pine Bluff, Ark.
372	13	Ammonia tank exploded	4		Parker Webb Packing Co.	Packing Plant	Detroit, Mich.
373	15	Section of heating boiler cracked			Ascher Bros.	Theater	Chicago, Ill.
374	15	Section of heating boiler cracked			Town of Milford	Town Hall	Milford, Conn.
375	16	Sterilizer exploded	1		Corn State Serum Co.		Omaha, Nebr.
376	17	Tube collapsed		2	Pittsburgh Plate Glass Co.	Glass Factory	Chrystal City, Mo.
377	18	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
378	20	Boiler exploded		1	James Barber	Saw Mill	Williamsfield, O.
379	20	Boiler bagged and ruptured			Collwood Lumber Co.	Lumber Mill	White City, Tex.
380	23	Boiler bulged and ruptured			Troy Launderers & Cleaners	Laundry	Minneapolis, Minn.
381	23	Two tubes failed		1	A. O. Smith Corp.	Auto Factory	Milwaukee, Wis.
382	23	Feed water pipe failed			Sinai Kosher Sausage Factory	Sausage Factory	Chicago, Ill.
383	23	Main stop valve of boiler burst	5		Steamer Desoto	Steamer	Patux't River, Md.
384	24	Tube pulled out of drum		1	Hydro Electric Lgt. & Power Co.	Power Plant	Connersville, Ind.
385	25	Boiler exploded		3	Maysville Canning Co.	Canning Plant	Maysville, Wis.
386	27	Thresher boiler exploded	2	2	John A. Johnson	Threshing Mach.	Enid, Okla.
387	30	Section of heating boiler cracked			Mary L. Jones	Loft & Stores	Brooklyn, N. Y.
388	30	Section of heating boiler cracked			Mary C. Dillon	Commercial	New York, N. Y.
389	30	Tube ruptured	2	1	American Linseed Oil Co.	Oil Plant	New York, N. Y.

MONTH OF JULY, 1922.

390	1	Fire box of boiler ruptured			Western Ice & Bottling Co.	Ice Plant	Albuq'que, N. M.
391	3	Two tubes ruptured			Michigan Alkali Co.	Chemical Plant	Wyandotte, Mich.
392	4	Gauge glass fractured		1	Springfield Gas & Electric Co.	Power Plant	Springfield, Ill.
393	4	Two tubes ruptured		1	New York Central R. R. Co.	Railroad	West Seneca, N. Y.
394	5	Fire sheet bulged and ruptured			Muehling Packing Co.	Packing Plant	St. Louis, Mo.
395	5	Section of heating boiler cracked			Wolfe Tavern Co.	Hotel	Newburyp't, Mass.
396	6	Boiler exploded	1		B. F. Burch	Saw Mill	Barbourville, Ky.
397	7	Two tubes ruptured		2	Citizens Electric Co.	Power Plant	Battle Creek, Mich.
398	8	Two sections of heating boiler cracked			Mrs. A. V. Norcross	Mercantile Bldg.	Monson, Mass.
399	9	Header cracked			Amicable Life Ins. Co.	Office Bldg.	Waco, Texas

MONTH OF JULY, 1922 (Cont'd.)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
400	9	Head failed			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
401	10	Boiler bagged and ruptured			Whitney Mfg. Co.	Cotton Mill	Whitney, S. C.
402	10	Autogenous weld on boiler ruptured			Tway Bros.	Blacksmith Shop	San Francisco, Cal.
403	10	Boiler of thresher plant exploded	2	4	Ashton Farm	Thresher	Piqua, O.
404	10	Boiler exploded			Moon Farm	Oil Well	Parker, Ind.
405	10	Boiler exploded		1	Mr. Williamson	Thresher	Jasper, Mo.
406	10	Boiler flue ruptured		2	Reeves Mfg. Co.		Dover, O.
407	11	Air tank exploded		1	H. Hansen	Vulcanizing Plt.	San Antonio, Tex.
408	11	Header burst and damaged tube			Nichols Copper Co.	Copper Plant	Laurel Hill, N. Y.
409	12	Crown sheet collapsed			Pure Oil Co.	Oil Well	Mexia, Tex.
410	13	Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
411	13	Boiler bagged and ruptured			Marion Ice & Cold Storage Co.	Ice Plant	Marion, Ind.
412	14	Boiler exploded		3	Stauffer Chemical Co.	Sulphur Plant	San Francisco, Cal.
413	15	Boiler bulged			H. G. Bohlssen Mfg. Co.	Lumber Mill	Ewing, Tex.
414	15	Section of heating boiler cracked			Bd. of Public Education	School	Pittsburgh, Pa.
415	17	Two tubes ruptured			Penman, Littlehales Chemical Co.	Factory	Syracuse, N. Y.
416	18	Steam pipe exploded		13	U. S. S. New York	Battleship	P't Angeles, Wash.
417	20	Six sections of heating boiler cracked			Hartford Golf Club	Club House	W. Hartford, Ct.
418	20	12" throttle valve of engine failed			Sharp Mfg. Co.		New Bedf'd, Mass.
419	21	Steam calliope exploded		2	Woodland Grove	Pleasure Park	New London, Ct.
420	21	Three tubes pulled out of drum of boiler			Stimson Mill Co.	Lumber Mill	Seattle, Wash.
421	24	Tee in main steam line ruptured			Jacobs Candy Co.	Candy Factory	New Orleans, La.
422	24	Section of heating boiler cracked			Nellie Magid	Mercantile Bldg.	St. Louis, Mo.
423	25	Section of heating boiler cracked			Indian Refining Co.	Oil Refinery	Indianapolis, Ind.
424	26	Tube ruptured			Armour & Co.	Packing Plant	Chicago, Ill.
425	26	Boiler exploded			California Tire Co.	Vulcanizing Plt.	Petaluma, Cal.
426	26	Section of heating boiler cracked			Service Motor Truck Co.	Garage	Chicago, Ill.
427	26	Boiler ruptured			Henryellen Coal Co.	Coal Mine	Henryellen, Ala.
428	27	Steam pipe on locomotive crane failed			Solomon Bros.	Junk Yard	Pittsburgh, Pa.
429	27	Header fractured			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
430	27	Air tank exploded			Burghardt & Ingenthrone	Machine Shop	Hays, Kans.
431	27	Two headers burst			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.

432	28	Main steam pipe burst			Tug, Harold J. Reichert	Tugboat	New York, N. Y.
433	29	Tube ruptured			Woodward Iron Co.	Iron Mills	Woodward, Ala.
434	30	Throttle valve of steam engine burst		1	Haven Malleable Castings Co.	Foundry	Cincinnati, O.
435	31	Tube ruptured			City Hospital	Hospital	Akron, O.
436	31	Valve on main steam line ruptured			Pike Manufacturing Co.	Scythestone Mill	Pike Station, N. H.
437	31	3″ steam pipe ruptured			Ajax Rubber Co.	Auto Tires	Racine, Wis.
438	31	Fire sheet cracked			Citizens Ice, Coal & Supply Co.	Ice Plant	Sidney, O.
439	31	Ammonia tank exploded			Etna Ice Co.	Ice Mfg.	West Etna, Penn.

MONTH OF AUGUST, 1922

440	1	Boiler of locomotive exploded	1		Wisconsin & Alabama Lumber Co.	Lumber Mill	Sylacauga, Ala.
441	2	Boiler exploded	5		Steamer Edward	Tugboat	Brooklyn, N. Y.
442	3	Boiler exploded	2		A. M. Berry	Laundry	B'k'n Arrow, Okla.
443	3	Boiler of locomotive exploded		2	New York Central R. R.	Railroad	Rochester, N. Y.
444	3	Tube ruptured			Pine Bluffs Co.	Power Plant	Pine Bluffs, Ark.
445	3	Boiler exploded	1	5	Edward Hines Yellow Pine Trustees	Lumber Mills	Lumberton, Miss.
446	4	Tube ruptured	1		Moss Tie Co.		Valley J'tion, Ill.
447	4	Tube ruptured			Congress Hotel	Auditorium	Chicago, Ill.
448	4	Tube ruptured			Woodward Iron Co.	Iron Mills	Woodward, Ala.
449	5	Thresher boiler exploded		1	E. G. Lynch	Threshing Outfit	Creston, Ia.
450	6	Tube ruptured	1		S. S. Rosemary	Steamship	Chelsea, Mass.
451	7	Boiler exploded		1	Cranberry Creek Coal Co.	Coal Mine	Hazleton, Pa.
452	7	Main steam line exploded			Union Mills		Hudson, N. Y.
453	8	Blow off pipe failed			Lassen Lumber & Box Co.	Lumber Mills	Susanville, Cal.
454	8	Flue of boiler ruptured		1	Eastern Wisconsin Electric Co.	Power Plant	Sheboygan, Wis.
455	9	Main steam line failed			Waltham Spaghetti Co.	Spaghetti Factory	Waltham, Mass.
456	9	Tube ruptured			Keystone Grain Products Co.	Yeast Factory	Philadelphia, Pa.
457	9	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
458	9	Fire sheet bulged and ruptured			Hocking Valley Cereal Bev. Co.		Nelsonville, O.
459	10	Boiler bulged and ruptured			Frankfort Ice & Coal Co.	Ice Plant	Frankfort, Ky.
460	11	Boiler exploded		5	Derrick Boat No. 10	Derrick Boat	Chilo, O.
461	15	Thresher boiler exploded	1		Moe Farm	Farm	Momence, Ill.
462	15	Crown sheet bulged			Chas. M. Dodson & Co.	Coal Mine	Dieblers, Pa.
463	16	Threshing machine boiler exploded	3	4	Wiley Farmer	Farmer	W. Jefferson, N.C.
464	16	Superheater of locomotive exploded		2	C. C. C. & St. L., R R.	Railroad	Springfield, O.
465	17	Flue of locomotive boiler exploded		1		Railroad	Le Grande, Ore.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1923

Capital Stock, . . $2,000,000.00

ASSETS

Cash in offices and banks	$532,313.26
Real Estate	255,000.00
Mortgage and collateral loans	1,797,550.00
Bonds and stocks	7,170,021.35
Premiums in course of collection	886,034.35
Interest Accrued	125,956.83
Total assets	$10,766,875.79

LIABILITIES

Reserve for unearned premiums		$4,979,417.54
Reserve for losses		311,286.82
Reserve for taxes and other contingencies		423,444.37
Capital stock	$2,000,000.00	
Surplus over all liabilities	3,052,727.06	
Surplus to Policyholders		**$5,052,727.06**
Total liabilities		$10,766,875.79

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President and General Counsel.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Directors, United States Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BUCKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.
SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, Vice-President, Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866. THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLY-WHEEL EXPLOSIONS AND ENGINE BREAKAGE

Department	Representatives
ATLANTA, GA., 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, CT., 404-405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'v'l'd	J. F. Criswell, Manager. P. M. Murray, Ass't Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	A. Paul Graham, Manager. L. T. Gregg, Chief Inspector.
DENVER Colo., 916-918 Gas & Electric Bldg.	J. H. Chestnutt, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, General Agent. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't. Chief Inspector.
NEW YORK, N. Y., 80 Maiden Lane	C. C. Gardiner, Manager. E. Mason Parry, Chief Inspector. R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickham, Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrott Bldg.	Geo. S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
PORTLAND Ore., 306 Yeon Bldg.	McCargar, Bates & Lively, General Agents. C. B. Paddock, Chief Inspector.
SEATTLE, Wash., 301 Thompson Bldg.	C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co. General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager Eugene Webb, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.

THE HARTFORD LINE

BOILER INSURANCE

Boilers, Economizers, Vulcanizers, Kiers, Digesters, Steam Driers, Jacketed Kettles, Etc.

FLYWHEEL INSURANCE

Flywheels, Fans, Blowers, Turbines, Water Wheels, Centrifugal Driers, Gear Wheels, Etc.

ENGINE INSURANCE

Engines, Compressors, Pumps, Refrigerating Machines, Etc.

ELECTRICAL MACHINERY INSURANCE

Generators, Motors, Synchronous Convertors, Transformers, Switchboards, Etc.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER INSPECTION and INSURANCE CO.
HARTFORD CONNECTICUT

"The *oldest* in the Country, the *largest* in the world"

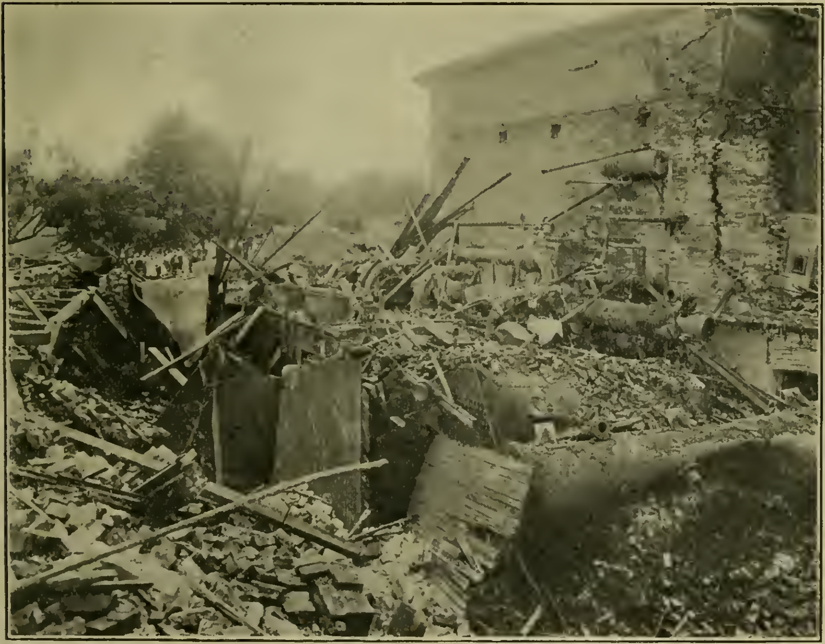
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

Vol. XXXIV. HARTFORD, CONN., OCTOBER, 1923. No. 8.

COPYRIGHT, 1923, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

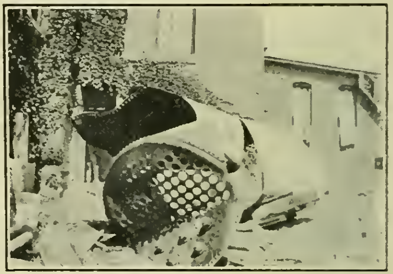


BOILER EXPLOSION AT GREENWOOD, S. C.

Boiler Explosion at Greenwood, S. C.

SOME degree of appreciation of the extreme violence which boiler explosions frequently attain and of the havoc which results may perhaps be had by a glance at the illustration on the cover page of this issue of THE LOCOMOTIVE. We have seen no picture, however, that can do full justice to the scene presented on the evening of May 15th, 1923, at the Grendel Mills, Greenwood, S. C., where this boiler explosion took place. As a result of the accident two men were killed and two were injured and the property loss, but partly shown in the illustration, amounted to approximately $50,000. Aside from the destruction of the buildings, considerable damage was done to the cotton yarns and fabrics in process of manufacture.

The circumstances leading up to and the observations made previous to the explosion are rather interesting. It appears that the boiler, which was of the horizontal return tubular type and twenty-seven years old, had just had the brick setting renewed. At about three o'clock in the afternoon of the day of the accident an hydraulic test pressure was applied and a pressure of 130 lbs., at which the safety valve apparently lifted, was recorded. Following this a slow fire was ordered built under the boiler to dry out the setting. At about six o'clock an observer noted a reading of twelve pounds on the pressure gauge. A couple of hours later and only a few minutes before the explosion took place the engineer passed by and observed a reading of practically zero on the gauge. At about 8:30 in the evening the boiler exploded.



THE EXPLODED BOILER.

The initial rupture appears to have occurred through the nozzle and manhole, both of which were in the second course, and continued along the entire top of the boiler through the solid sheets of the front and rear courses. The front head and first course were thrown diagonally to the front and landed about 30 ft. away. The second and third courses and rear head were thrown as a unit diagonally to the rear and landed about 100 feet away, stopping just short of the main mill building. This portion of the shell not only opened out, but actually curved backward, inside out, as may be noted from the illustration on the opposite page. A 16 ft. length of the steam header sailed over the main building and landed about 500 yds. away. The adjoining boiler, which was unfired, was crushed in, and its setting as well as that of a third boiler was a complete loss. The boiler house was leveled. Additional damage was caused by tubes, grate bars, etc., falling through the roof of the mill building, and rain did considerable damage to the textile material and machinery.

An explosion as terrific as this one would indicate overpressure as the cause. The concussion was so great that practically all the glass in the windows of the plant was shattered and rumor became current that the building had been lifted bodily and moved a slight distance. This, of course, was unfounded.

Fortunately, a Hartford policy was in effect, the owners being thereby indemnified for their loss.

Safety Valves.

Their Size, Adjustment and Installation.

By J. A. Snyder, C. I., Pittsburgh Dept.,
and
Wm. D. Halsey, Editor, The Locomotive.

It is said that safety ends and danger begins when carlessness is allowed to come in. A safety valve on a boiler may be in fact a safety valve, operating to limit the pressure or, through carelessness and neglect, it may become the agent of widespread destruction.

The history of steam boiler operation is replete with disastrous explosions resulting from defective safety valves. To be sure, the old lever type valve, productive of many accidents, has now fallen greatly into the discard, and is even outlawed, so far as modern steam boiler practice is concerned, yet there are a considerable number of them still in use. The modern spring loaded pop safety valve is a comparatively reliable piece of apparatus but it can become, through neglect, a positive menace to safety.

It is the intention in this article to explain the action of a safety valve, to remark briefly upon the method of adjustment, to show how the size should be determined and to describe how such valves should be installed. In a subsequent article we shall deal with the care and inspection service that safety valves should receive.

The dead weight type of valve, which is perhaps the oldest and at the same time the simplest, is illustrated in the cross sectional view Fig. 1. The action of the weights is very direct and, as will be readily seen, the total weight of the valve and the weights carried by it is equal to the area against which the steam acts multiplied by the steam pressure per square inch. This type of valve, while simple, is suitable only for low pressures and rates of discharge. For high pressure and large volumes, it cannot be considered because of the large size that would be required.

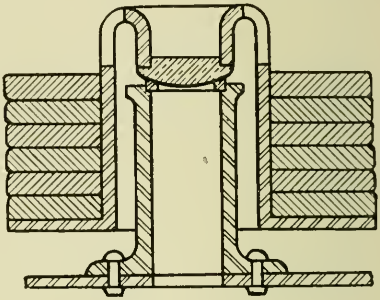


Fig. 1.

To adapt the principle of a dead weight to high pressure and large volumes the principle of the lever was brought in and resulted in the well known type of ball and lever valve as shown in Fig. 2. While an improvement over the plain dead weight type, it too was limited, as, with the ever increasing pressures and sizes of boilers, its adaptability also was exceeded. The fundamental principle of these two valves is the same. The lever type is less cumbersome but the introduction of bearings and guides complicates the design and gives rise to the chance of binding the action.

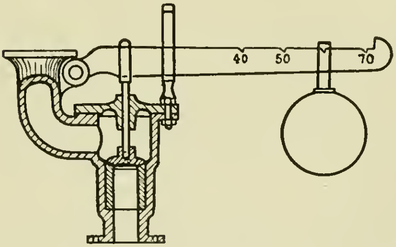


Fig. 2.

Furthermore, this type of valve was a frequent source of trouble because of its uncertain action. A valve which would open at say 100 lbs. pressure might fail to close until the pressure had been reduced to 90 lbs. and of course such action was extremely wasteful of steam and greatly interfered with the operation of the plant. This excessive "blow-down" was the result of an action which can perhaps be made clearer by reference to Fig. 3. Here we have a cross sectional view of a plain disc valve on its seat with dimensions as shown. When this valve is held to its seat with a total pressure of 1000 lbs. it would require a steam pressure of 100 lbs. per sq. in. (10 sq. in. x 100 lbs.) to open it. As soon as it does open, however, the steam has a chance to act on an area of 13.33 sq. in. The valve would then open very wide and before the weight could reseat the valve the pressure would drop considerably. If it were possible for the full boiler pressure to act on this larger area, the pressure would drop as low as 80 lbs. Of course the full boiler pressure would not act on the larger area because there would be some drop in pressure of the steam when it passed between the surfaces of the valve and the valve seat. However, some such increase in the total lifting force of the steam is effected and the excessive and uncontrollable amount of blow-down which results was one of the reasons for this type of valve being discarded.

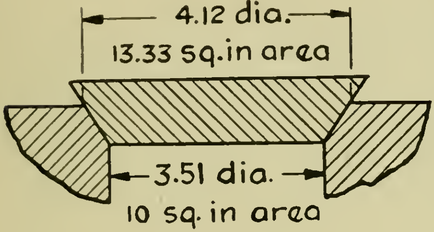


Fig. 3.

Another point to be considered is that while any type of valve must permit of adjustment to the desired relieving pressure, yet the more readily an adjustment can be made, the more chance there is of careless or irresponsible persons tampering with the setting of the valve so as to permit the building up of a dangerous pressure. The dead weight and modern spring pop types of valve can readily be made of a "lock-up" design which will protect them, to a very large degree, against mistreatment. Such is not the case, however, with the lever type of valve. Many a thoughtless operator, in the desire to obtain a higher pressure to carry the plant over a peak load, has been guilty of hanging too great a weight on such a valve and in many instances, explosions have resulted from this very cause.

In a valve using a dead weight the pressure on top of the valve is constant. If a spring be used to exert pressure on an ordinary type of valve, the action when the valve opens would not be very satisfactory because, as the spring is compressed, the pressure it exerts is increased. Consequently such a valve would open only a very small amount to release steam and before any great amount could escape the pressure would build up considerably unless a very large valve or a number of small ones were in use. This, however, would in all probability introduce chattering of the valves, which trouble we will deal with later on.

In the modern "pop" safety valve we have a spring-loaded device, readily adapted to high pressure use, which will open to a definite point and which can be adjusted to a definite blowdown. Various designs are used to attain these features, although the underlying principle is the same. This may be explained by reference to Fig. 4.

In this cross sectional view of a typical safety valve, the valve is shown in its closed position. Steam at full boiler pressure can then act upon the area of a circle whose diameter is B. As soon as the pressure becomes high enough to lift the valve disc, steam will rush through into the "huddling chamber", as it is called, and the pressure will then act on the area of a circle whose diameter is C. Since C is considerably larger than B, the total pressure available to compress the spring is greatly increased and the valve "pops" open. How far it will rise depends largely on the opening that there will be between the downward projecting lip on the valve disc at its outside edge and the upward projecting lip of the adjusting ring at A. The constricted flow of steam between the edges of these two lips is, of course, responsible for the pressure in the huddling chamber. Some designs, by turning the steam downward before it escapes from the huddling chamber, make use of the reactive effect of a high velocity jet to help raise the valve disc.

The adjusting ring, it will be noted, is threaded onto the valve body or seat and provision is made whereby this ring may be turned on the screw thread thus moving it up or down. A little thought regarding the position of this adjusting ring should make it clear that if the ring were moved down far enough the flow of steam will not be restricted at all and no pressure would be built up in the huddling chamber. With such an arrangement, the valve, in all probability, would open and close very rapidly with a fluttering action because, of course, as soon as it did open the flow of steam from the boiler would reduce the pressure beneath the valve disc and the valve would close. Immediately, however, the pressure beneath the disc would rise to the pressure in the boiler and the valve would again open to release a slight amount of steam. This rapid action of opening and closing, or "chattering", would continue until sufficient steam was discharged from the boiler. However, the action would be very noisy and

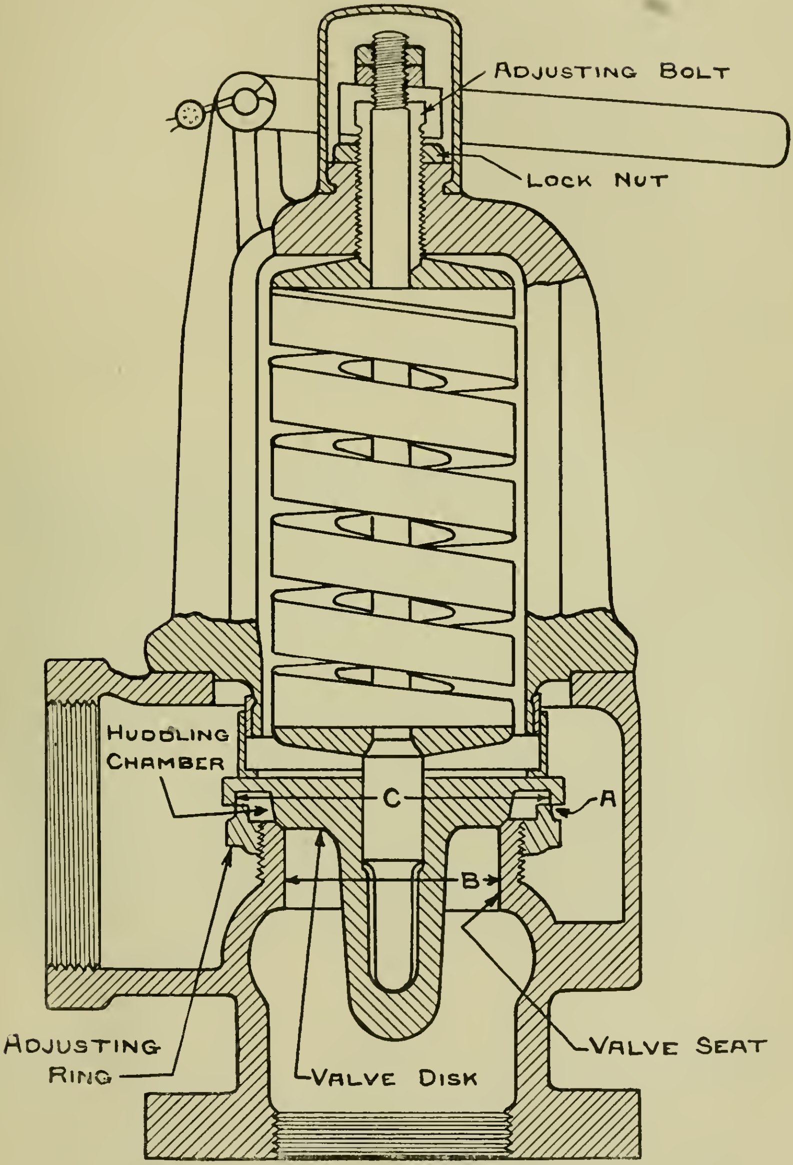

ADJUSTING BOLT
LOCK NUT
HUDDLING CHAMBER
C
A
B
ADJUSTING RING
VALVE DISK
VALVE SEAT

FIG. 4.

the valve would soon wear out because of the hammering of the disc on its seat. On the other hand, if the adjusting ring were moved upward so as to restrict the steam discharge, the valve disc would rise to a definite opening when the valve "popped" and would remain open until the pressure in the boiler was considerably reduced. By moving the adjusting ring to some intermediate position, a smooth and easy action of the valve, together with a reasonable "blow-down", or reduction of pressure, can be obtained.

Various designs are used to effect the action just described, although the object in all of them is the same.

The adjustment of a safety valve is a matter requiring great care and due regard must be given the serious consequences that may result if a mistake is made. Bear in mind at all times that steam gauges are liable to get out of order as well as safety valves. Before changing the setting of a valve or the pressure at which it will blow, the steam gauge should be checked to see that it is absolutely correct and that the pipe from the boiler to the valve is clear so that the true pressure within the boiler may be registered. Adjustments should be made at a time when there is little demand for steam, as, for instance, in the evening, so that a low steam pressure may be carried, thereby avoiding the danger of anyone being scalded by the safety valve opening while the adjustments are being made.

To increase the pressure at which the valve will blow, slacken the check nut (see Fig. 4) and screw down the adjusting bolt, or nut; to decrease the pressure, screw up to release some of the tension on the spring. Marks to serve as guides should be made on the adjusting bolt head or nut and on the casing before any change is made.

In adjusting a valve with which one is unfamiliar and having first of all reduced the steam pressure considerably below the ordinary working pressure, it is advisable, as a preliminary step, to release the tension on the spring by a half turn of the adjusting bolt. The steam pressure can then be raised and the pressure noted at which the valve opens. From the results of this test some idea may be had of how far from its original position the adjusting bolt must be moved to effect the desired change in the setting of the valve.

Care should be exercised not to tighten down too much in the attempt to raise the blowing point of a safety valve because there is danger of tightening down until the spring coils are touching each other and the valve then could not raise from its seat. As the manufacturers do not advise more than about ten per cent variation on the springs, a new spring should be secured if the valve does not function properly when alterations have been made that would equal this amount.

Paragraph 281 of the *A. S. M. E. Boiler Code* states that: "Safety valves shall operate without chattering and shall be set and adjusted as follows: To close after blowing down not more than 4 lbs. on boilers carrying an allowed pressure less than 100 lbs. per sq. in. gage. To close after blowing down not more than 6 lb. on boilers carrying pressures between 100 and 200 lb. per sq. in. gage inclusive. To close after blowing down not more than 8 lb. on boilers carrying 200 lb. per sq. in. gage."

UNFAMILIARITY WITH THE PROPER ADJUSTMENT OF SAFETY VALVES CAUSED THIS BOILER EXPLOSION.

By having the blow-down adjusted for too small a pressure drop, the safety valve blows too often and chattering is also more likely to take place. On the other hand, if the blow-down is excessive too much steam is wasted. When adjustments of the blow-down are necessary or when repairs are to be made on a valve and the workman is not thoroughly familiar with the steps to be taken, the valve manufacturer or someone thoroughly familiar with the subject should be consulted.

Many boiler attendants seem to forget the purpose of the try-levers and do not keep them in place on the valves. If they were known as proof levers they might have better recognition and be used oftener because by their proper use it can be proven that the valve is not stuck or seriously overloaded, which is a very important factor in the safety of the power plant.

When boilers are being tested by hydrostatic pressure the safety valve springs should not be screwed down, but the valve should be held tight on the seat by having the valve spindle held down by the use of test clamps designed for that purpose and which may be purchased or can be made at little cost. Screwing the safety valve springs down tight to permit testing the boiler may cause the springs to become erratic, if it does not ruin them.

When test clamps are used on safety valves, **do not fail to remove them immediately after the test** is completed. Disastrous explosions have resulted from neglect in this regard.

Safety valves less than one inch size are usually light in construction and it may be said in general that sizes smaller than that should not be used. On the other hand, to avoid shocks, it is well to use none larger than 4½ in. on steam boilers, but to install several where the capacity of the 4½ in. size is not sufficient. The total force required to lift a 4½ in. valve at a pressure of 150 lbs. per sq. in. which today is considered only a moderate pressure, is about 2400 lbs. or somewhat more than a ton. If the valve lifts ⅛ in., the energy of the valve disc when it strikes the seat would be ⅛ in. x 2400 lbs. or 300 inch-pounds which energy must be almost instantly absorbed by the valve disc and its seat. The "punishment" that a safety valve must stand is, therefore, rather severe.

The proper size and number of safety valves to use on any given installation is, to a certain degree, difficult to determine. The rules for the determination of safety valve capacity, as given in the *Boiler Code of the A. S. M. E.*, represent modern practice in this regard.

The method of determining the required safety valve capacity by these rules is first of all to ascertain the square feet of water heating surface contained in the boiler. The assumption is then made that every square foot of such surface may evaporate 6 lbs.

of steam per hour in a water tube boiler whatever the working pressure, 5 lbs. per sq. ft. in other types when the pressure is above 100 lbs. and 3 lbs. per sq. ft. when the pressure is at or below 100 lbs. The reason for the difference in these rates of evaporation is the consideration given the class of service, it being assumed that a fire tube boiler working at a pressure less than 100 lbs. would not be afforded the furnace capacity to evaporate more than 3 lbs. per sq. ft. of heating surface.

If we multiply the square feet of heating surface by the assumed rate of evaporation, as outlined above, we obtain as a result the total weight of steam per hour that the boiler can generate even when forced considerably above its rated capacity. From tables of safety valve discharge capacities, which may be found in the *Code* or may be obtained from any safety valve manufacturer, we can then determine what size valve should be used.

In deciding on the size and number of safety valves, it should be borne in mind that only when the total discharge is 2000 lbs. per hr. or less may one valve be used. Also, of course, there is the upper limit of 4½ in. in the size of valve that is considered advisable to use.

The *Code* requires that there should be sufficient safety valve capacity to discharge all the steam the boiler can generate without allowing the pressure to rise more than 6% above the maximum allowable working pressure. Whereas the method outlined above for determining the number and size of safety valves to be used is fairly certain to give the proper results, on the other hand, the safest procedure is to test these valves to see that they will hold the pressure within the specified limits. This may be done by an accumulation test which consists of closing off all steam outlets from the boiler and forcing the fire to the utmost. All the steam that the boiler can possibly generate must then be discharged through the safety valves and a very definite assurance of sufficient capacity is obtained.

When it is not convenient to thus cut the boiler off the line for a test, the safety valve capacity may be checked by measuring the amount of water fed to the boiler or by weighing the fuel burned and making such computations as are outlined in the *Code*.

We have not attempted to point out all the provisions of the *Code* as regards safety valves, for there are many angles to the matter. Those who have supervision of boilers will find it advantageous to read that part of the *Code* pertaining to safety valves, and to become thoroughly conversant with the rules.

In regard to the capacity of safety valves for use at low pressures, it is necessary to observe that, for the same rate of discharge in pounds per hour, a larger valve must be used than for higher pressures. There are two reasons for this. First of all, the lower the pressure, the greater the volume occupied by a pound of steam. At 15 lbs. pressure a pound of dry steam occupies nearly 14 cu. ft. whereas at 150 lbs. pressure the volume is but 3 cu. ft. From this consideration alone it would appear that a valve for 15 lbs. pressure would have to be nearly five times as large as one for 150 lbs. pressure. In addition it must be remembered that, with the range of pressures encountered in heating boiler practice, the greater the difference between the atmospheric and the boiler pressure the greater will be the flow of steam. Due care must therefore be given the selection of a safety valve for this kind of an installation in order that an excessive pressure may not be built up. Assistance in this regard may be gained from that part of the *A. S. M. E. Code* which applies to heating boilers. Power boilers that have been operated at a high pressure and later used for low pressure heating should have low pressure safety valves installed. The spring of the high pressure valve is not suitable for the low pressure and in most cases where a boiler is changed from power to heating service the size of the safety valve should be increased unless the grate area is considerably reduced.

Many heating boiler explosions can be traced to neglect of the safety valves, whereby they become inoperative and when a safety valve will not function as intended the pressure increases and the result is an explosion from over-pressure.

Safety valves should be placed in an upright position since this position permits a freer action of the moving parts and a better seating of the disc on its seat. It is extremely important that they be attached to a boiler independent of any other connection and as close as possible to the boiler shell. There should be no valve between the boiler and the safety valve or on the discharge pipe leading from the safety valve.

Long pipes leading from the boiler to the safety valve should not be used because, when the valves opens, the flow of stream in this pipe causes a drop in pressure between the boiler and the valve and chattering is often the result. Long pipes are also undesirable because of the strain that is thrown on the connections by the reaction effect of the discharging jet of steam.

A factor not to be lost sight of in the locating of safety valves is that of accessibility. A valve that is readily reached is likely to receive better care than one that is inconvenient to reach.

When several safety valves are necessary on a boiler they may each have their own nozzle connecting them to the boiler or they may be installed in pairs on a yoke or " Y " fitting. When several valves are used the *A. S. M. E.* Code states that " One or more safety valves on every boiler shall be set at or below the maximum allowable working pressure. The remaining valves may be set within a range of 3 per cent above of the maximum working pressure, but the range of setting of all of the valves on a boiler shall not exceed 10 per cent of the highest pressure to which any valve is set."

The matter of discharge pipes is a most important one. No discharge pipe at all would be the most desirable arrangement from the standpoint of free discharge. The safety of attendants, however, must be kept in mind, and frequently, escape pipes must be used as for instance when there are passageways on top of the boilers where persons passing by might be injured by the escaping steam or when the space is too confined and the steam discharged must be led outside. When discharge pipes are installed they should be as short and direct as possible and so arranged as not to throw strains on the valve, and thereby distort the seat and cause the valve to leak. Two pieces of pipe with an elbow so arranged as to turn the escaping steam upward is all that is usually required. The elbow should be located close to the discharge opening of the valve and the vertical discharge pipe leading from the elbow should be long enough to conduct the steam above the head of anyone who might be working on top of the boiler. We have heard of cases of the safety valves being so installed that the escaping steam was discharged against the manhole of an adjoining boiler. Men who were sent into this adjoining boiler to clean it were trapped there when the safety valves of the boiler under steam opened and, because the safety valve did not close for some time, were smothered to death.

When a long discharge pipe is necessary to conduct the steam out of doors, it should be made one or two sizes of pipe larger than the discharge opening of the valve. It is well to have such pipes run down hill all the way from the valve and whatever arrangement of discharge piping is made, care should be taken to install an ample sized drain at the lowest point so that there will be no opportunity for water to collect.

Attention should be paid to the possibility of anything falling into or over the end of the discharge pipe so as to prevent free discharge. In one instance that we know of, gravel from a belt conveyor dropped into the vertical discharge pipe from a safety valve and seriously interfered with the proper discharge of the steam.

It is sometimes necessary, in order to reduce the noise of the discharge from a safety valve, to install a muffler. If such a device is used it should have ample outlet area so as to prevent back pressure from interfering with the proper operation of and discharge of steam from the valve.

In ordering safety valves it is important to state the size, the relieving pressure, the lift (high, medium or low), the kind of service, the drilling of the flanges (if a flanged valve) and any other information that would appear of value. If the manufacturer's catalog is at hand the catalog or list number should be given. If the valve is intended for use in a state operating under the *A. S. M. E. Boiler Code* as a standard, it should be specified that the safety valve is to comply with the A. S. M. E. rules. This is a good requirement to make of safety valves for use in any locality.

Fiber in Metals.

THE association of a fibrous structure with strong and tough materials, such as wood and rope, and the corresponding association of crystalline character with weak and brittle materials, such as sugar or bismuth, has produced in the minds of many men, and even of competent engineers, the conception that all really strong and tough materials must be fibrous, and that all crystalline substances are likely to be weak and brittle.

A study of their microstructure, however, shows that all metals in a normal condition — i. e., when not severely cold-worked — are entirely crystalline, and that the minute crystals of which they are composed show no orientation of predominant length. There is, therefore, nothing in the nature of a "fiber" in the metal itself. The individual strips or bars into which a thick bar or plate becomes more or less completely divided by the presence of "slag" bands can never be any the stronger on that account. The metal itself, in fact, possesses no real fiber; its longitudinal strength appears greater than its transverse strength only because in the transverse direction the enclosure bands make their weakening presence felt far more actually than in the longitudinal. Were they entirely eliminated, the metal would be equally strong in all directions, and yet there would be no sign of "fiber."

It would thus seem that the desire for a "fibrous" structure is in essence a mistaken one, and that the cause of the fibrous appearance is in reality a weakness and not an advantage. It is true that under certain bending tests in which the power of the metal to undergo a large amount of plastic bending constitutes the main factor, the "fibrous" material shows higher results. Here the fibrous material gains a spurious advantage from the fact that it is enabled to behave very like a bundle of bars or thin plates rather than as a single piece of material. Owing to the weakness of the slag layers, the various rods and plates are approximately free to slide over one another and a larger amount of bending occurs before fracture takes place. But this is no real gain for practical use.— *The Engineer* (London.)

An Engine Accident at Yale, Michigan.

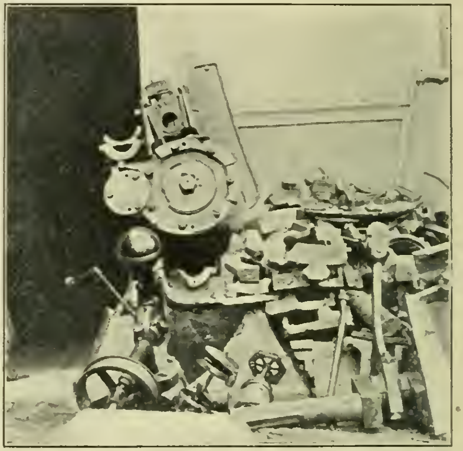
By J. P. Morrison,
Chief Inspector, Chicago Department.

AN engine accident, which we believe is the most complete wreck of this kind that has yet come to our attention, occurred not long ago at Yale, Michigan. It is not certain that all of the parts were recovered, but 186 pieces were counted by those who assisted in clearing up the debris. The engine wheel had broken into 31 parts.

The engine was of a well known make, and operated at 300 r. p. m. Its cylinder dimensions were 7″ in diameter, with 7″ stroke, and the fly wheel was 36″ in diameter. The engine had been purchased second hand, after being rebuilt, and had been in operation but about ten days when the accident occurred.

The night watchman, who had charge of the engine and small generator it operated for lighting purposes when the balance of the plant was idle, was said to have been making his clock-punching tour of the mill, when he heard a considerable noise as of an explosion, followed by failing of the electric lights; so it is not possible to determine which of several possible causes was primarily responsible for the accident. However, the engine governor was of the throttling type, which was fully described in a paper on PREVENTION OF FLY WHEEL EXPLOSIONS, which appeared in THE LOCOMOTIVE of July, 1915.

There are two kinds of throttling governors, one termed the automatic, and the second the non-automatic. The former will, and the latter will not, prevent the cylinder from obtaining steam, should the governor belt break or fall from the the governor pulley. The governor of the engine in question was of the non-automatic type, and it is possible the accident was due to the governor belt leaving the pulley, which would give the cylinder full steam pressure, and under the light load condition, would cause over-speeding, which would require but a few seconds to bring the wheel up to a disrupting speed.



REMAINS OF WRECKED ENGINE.

The engine was so completely wrecked that it would seem there must have been other contributing causes, and as one of the stud bolts holding the counter-balancing weight onto the crank had an old flaw, which included about one-half of the cross sectional area of the bolt, it is possible the failure of this bolt permitted the counter-balance to drop into the crank case, where it lodged in such a position as to prevent the further rotation of the crank. In fact, the crank had a mark of sufficient depth to give considerable weight to this idea.

The crank shaft, with at least a part of the wheel attached, left its proper position. The wheel defaced a brick wall, leaving a clear outline of about one-third of its circumference, and the foundation for the outboard bearing of the large mill engine was broken by the shaft, or wheel, so those parts went in that initial direction, although parts of the wheel were found scattered all over the premises. An 8″ x 8″ timber was severed by one piece of the wheel which weighed about 50 tons, and which continued through the engine room roof and landed in the third story of another building across a 25 ft. roadway. One part of the wheel passed through a 24″ brick wall about 15 ft. above the engine room floor level, while another piece apparently circled the room, boomerang fashion, and demolished the switchboard. The spokes of the wheel, and other parts of the engine, were well distrbuted over the plant, and considerable damage was done to the transmission rope system which drives the mill from the large engine.

Close examination of the broken parts which were recovered, disclosed an old crack in the engine frame and a cracked wheel spoke, as well as some casting flaws, any of which might have contributed to the general failure.

It was indeed fortunate the accident did not occur during the operating hours of the factory, for it is hardly possible all would then have escaped injury.

The Discovery of Manganese Steel.

HADFIELD'S discovery of manganese steel as a result of research practically started the study of alloy steels. Before him, Mushet had, indeed, worked out empirically a self-hardening steel for metal-cutting tools, but it gave no such impetus to research in the field of useful metals. As a young man Hadfield started experimenting in his father's steel foundry to see if he could find a hard steel suitable for tram-car wheels. He melted his mixtures in crucibles and tested his products by the means then at hand,— the file, chisel, forge, magnet, and hardening and tempering. These were enough to enable him when he first made an alloy coming within the definition of manganese steel to realize that he was dealing with a new metal.

Before his time, everyone who had tried the effect of increasing manganese in steel had found that the steel was made harder and less ductile with each increase, so that if 2.5 per cent were present the product was too hard and brittle to be of any use. The highest proportion ever added had been 3.5 per cent, which made the steel even more brittle. Naturally it was believed that more manganese would merely result in still greater weakness.

Hadfield, however, took nothing for granted but tried everything and as a result found the new alloy which, when it contained about 13 per cent of manganese, and was properly heat-treated, had maximum combined properties of strength and toughness. He told his father, Robert Hadfield, and his superintendent, Mr. Mallaband, about his discovery. They were naturally skeptical and told him that he would better repeat his experiments. He did so with the same result and then they began to take notice.

Here was a high-carbon steel which in several ways was the opposite of what would be expected by any one familiar with iron. A magnet would not attract it, and when heated to a bright orange heat and cooled quickly, as by immersion in cold water, it was given extraordinary ductility. There were other less notable features but these were enough to excite astonishment.

Naturally, the first attempts to adapt the new hard metal were for cutting purposes, particularly for metals, but experiments in that direction came to naught. The great field for this steel, resistance to abrasion, particularly by earthly materials such as rocks and ores, was not fairly recognized until ten years after the steel was first made.

The discovery, as the result of systematic research, of a metal having such unique properties as manganese steel, started other steel-makers to see whether additional useful alloys could be found. As a result of these activities, which eventually extended throughout the civilized world, many alloy steels have been developed of exceeding importance, which have advanced materially the useful arts and particularly the conquest of distance on land, in the air and under the sea.

This discovery also argues strongly for research even without a definite object. Hadfield was searching for a hard steel for another purpose. He had no idea of finding a non-magnetic or water-toughening steel. So anyone has a chance of finding something new and useful in any systematic investigation or research which explores any unknown field of knowledge.

As usual the inventor's reward was in this case an extremely small part of the benefit of manganese steel to the world. Years passed before the various uses for the steel were found. Everyone disbelieved when told of it. Trials for the various purposes had to be made to show its fitness. The development of the business side called for the liberal expenditure of time, effort and money. The life of the patent, 14 years, is too short a time to enable the inventor of anything of such extreme novelty to be suitably recompensed in a business way, though he may, as Sir Robert has, find satisfaction in having forwarded the welfare of the world in so great a degree.—*Research Narrative, Engineering Foundation.*

Caught in the Separator.

WATER IN BOAT BOILERS.

Water was discovered in the boilers of the Ohio river steamer P. Gillham, at Gallipolis, Monday night, Cincinnati rivermen were advised Tuesday. Fires were quickly drawn and the crew took to the barges, fearing an explosion. The boat reached shore without mishap, however, and repairs soon were made.— *Times Star, Cincinnati.*

SAN FRANCISCO QUAKE VICTIM LIVED 17 YEARS IN A BOILER.

San Francisco, March 5. — John McKenzie, driven into a discarded boiler in a vacant lot by the great fire and earthquake of 1906, has been driven from his junk yard home of seventeen years by another fire. The last blaze put him in a hospital.

McKenzie, a retired sea captain, was found on the street with his clothes burning. At the hospital, when questioned concerning the location of his burning residence, he told of the spot where investigators found the abandoned boiler fitted up with a bed and a bathtub.

McKenzie said that after three sleepless nights during the great fire he had crawled into the boiler and made his bed on the bricks still warm from the fire. He had stayed there ever since. He will recover from his burns and so will Patrolman Callahan, who was severly injured in saving the old man's life.— *New York Times.*

GROCER COOKS TONS OF SPUDS BY ACCIDENT.

Harry Frohman, a Columbus grocer, cooked more potatoes yesterday than his family can eat. In fact he has about a ton of cooked potatoes on his hands and he is wondering how he will dispose of them. It wasn't that Mr. Frohman over-estimated his appetite for potatoes but a steam pipe broke under his potato room and the escaping steam cooked the spuds.

Mr. Frohman received a car load of potatoes recently and stored them in the rear of his store. The weight of the potatoes caused the floor to sink until it broke a steam pipe running underneath the floor. Before the broken pipe was discovered twenty-one hundred pound sacks of potatoes had been cooked.— *Edinburg (Ind.) Daily Courier.*

The Locomotive

DEVOTED TO POWER PLANT PROTECTION
PUBLISHED QUARTERLY

WM. D. HALSEY, Editor.

HARTFORD, OCTOBER, 1923.
SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

SAFETY — the quality of making safe or secure, or of giving confidence, justifying trust, insuring against harm or loss." Such is the definition in the dictionary. It follows that a safety valve, since its purpose is to release excessive steam, should be a device that will remove the possibility of an over-pressure explosion.

Does the mere attachment of a safety valve to a boiler make it "safe and secure, justifying trust, insuring against harm or loss"? Unless that valve be of ample size, well designed and constructed, properly installed, adjusted and cared for so that it will operate as it was intended it should, we can have no assurance that it is a safety valve, even in a reasonable sense of the word. And, though all the above conditions have been met, it must be borne in mind that no mechanical device is infallible.

In this issue of THE LOCOMOTIVE there appears an article on Safety Valves with special reference to their method of operation, the determination of the proper size and the way they should be installed, and we believe it will be of help in this regard.

In a subsequent issue we intend to publish an article on the maintenance and inspection of Safety Valves.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF AUGUST, 1922 (Cont'd)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
466	18	Boiler exploded		3	Joe King	Saw Mill	Tuscumbia, Ala.
467	21	Tube ruptured		3	Rand-McNally Bldg.	Office Bldg.	Chicago, Ill.
468	21	Header cracked			Merchants Building Co.	Hotel	Toledo, O.
469	21	Staybolt pulled out			Natl. Cooperage & Woodenware Co.	Wood Mill	Shirley, Ark.
470	25	Tube ruptured			Monroe Co. Cotton Oil Co.	Cotton Gin	Aberdeen, Miss.
471	25	Water back pipe failed			Skinner Packing Co.	Packing Plant	Omaha, Neb.
472	26	Tube ruptured			Ajax Rubber Co.	Tire Factory	Trenton, N. J.
473	27	Thresher boiler exploded				Threshing Outfit	Dayton, O.
474	27	Hot water tank exploded			James H. Vahey	Residence	Watertown, Mass.
475	28	Thresher boiler exploded	2	5		Threshing Outfit	Carpio, N. D.
476	28	Section of heating boiler cracked			Zalm & Unger		Brooklyn, N. Y.
477	30	Safety valve of small boiler ruptured		1	Northwestern R. R.	Railroad Shops	Sterling, Ill.
478	30	Boiler exploded	1		McEwen & Sons	Paper Board Mill	Whippany, N. J.

MONTH OF SEPTEMBER, 1922.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
479	1	Drum of W. T. boiler ruptured			Groveton Paper Co.	Paper Mill	Groveton N. H.
480	2	Tube ruptured		2	H. G. Bates	Canning Plant	Wilmington, O.
481	3	Rendering tank collapsed			United Dressed Beef	Packing Plant	New York City.
482	3	Three headers cracked			Standard Steel Car Co.	Car Plant	Hammond, Ind.
483	3	Blow off pipe failed			F. J. Lewis Mfg. Co.	Roofing Mill	Chicago, Ill.
484	4	Boiler of locomotive exploded	1		Arkansas Lumber Co.	Log Railroad	Malvern, Ark.
485	4	Boiler of locomotive exploded	2	2	Lehigh Valley R. R.	Railroad	Sayre, Pa.
486	5	Cap in tube hole ruptured			Nichols Copper Co.	Copper Plant	Laurel Hill, L. I.
487	8	Tube ruptured			City Water Works	Pumping Station	Waukegan, Ill.
488	8	Tube ruptured		1	Sharpe & Dohme	Pharmactl. Pl.	Baltimore, Md.

MONTH OF SEPTEMBER, 1922 (Cont'd)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
489	8	Cover of rendering tank failed			E. E. Frith	Fertilizer Works	Dubuque, Ia.
490	8	Three tubes ruptured			Iowa Southern Utilities Co.	Power Plant	Centerville, Ia.
491	9	Boiler exploded		1	Niebergall Slaughter House	Abattoir	McMech'n, W.Va.
492	9	Fire sheet ruptured			D. W. Ray & Son	Cotton Gin	Kerens, Tex.
493	10	Valve in 6" steam line ruptured			Midvale Steel & Ordnance Co.	Steel Works	Philadelphia, Pa.
494	10	Steam pipe failed			Edward Hines Y. P. Trustees	Lumber Mills	Kiln, Miss.
495	11	Boiler of locomotive exploded	1	1	Columbus Lumber Co.	Lumbering	Columbus, Miss.
496	11	Steam pipe failed			Jessup & Moore Paper Co.	Paper Mill	Montchanin, Del.
497	12	Boiler exploded	1		Abe French Farm	Saw Mill	Madison, Pa.
498	12	Head of cylindrical drier cracked			Hammermill Paper Co.	Paper Mill	Erie, Pa.
499	12	Blow off pipe failed			West Branch Novelty Co.	Furniture Facty.	Milton, Pa.
500	13	Boiler exploded	1		Warren Deweese Mill	Saw Mill	Plattsburg, Miss.
501	13	4" pipe fitting failed			Columbia Chemical Co.	Chemical Works	Barberton, O.
502	13	Boiler bulged and cracked			Lily Ice Cream Co.	Ice Cream Facty.	Memphis, Tenn.
503	13	Blow off pipe failed			S. R. Hale & Co.	Cotton Gin	Gouldbusk, Tex.
504	15	Section of heating boiler cracked			Detroit Graphite Co.	Graphite Works	Detroit, Mich.
505	15	Boiler of locomotive exploded		2	Rock Island R. R. Co.	Railroad	W. Liberty, Iowa.
506	15	Drum of W. T. boiler ruptured			Grovetown Paper Co.	Paper Mill	Grovetown, N. H.
507	15	Section of heating boiler cracked			St. Paul's Episcopal Church	Church	Columbia, Pa.
508	16	Boiler exploded		3	Ernest Sawmill	Saw Mill	New Madrid, Mo.
509	16	Tube ruptured			American Metal Co.	Copper Smelter	Chrome, N. J.
510	19	Boiler exploded			L. G. Gibson		Warren, N. Y.
511	19	Locomotive crown sheet bulged & cracked			Missouri Portland Cement Co.	Cement Plant	F.Bllfntne, Mo.
512	19	Head of power boiler cracked			Charles L. Smith	Flour Mill	Freetown, Ind.
513	20	Head of boiler failed			Real Estate Trust Co.	Office Bldg.	Philadelphia, Pa.
514	20	Five tubes pulled out of drum			Milwaukee Coke & Gas Co.	Gas Works	Carrollville, Wis.
515	21	Boiler exploded			Pennsylvania R. R. Co.	Railroad Shops	Altoona, Pa.
516	21	Tube ruptured			W., C. F. & N. Ry. Co.	Power Plant	Waterloo, Ia.
517	22	Boiler exploded	1		South Texas Cotton Oil Co.	Cotton Oil Mill	Eunice, La.
518	22	Air tank exploded			Consumers Ice Co.	Ice Plant	Pine Bluff, Ark.
519	22	Tube ruptured			Pine Bluff Co.	Water Works	Pine Bluff, Ark.
520	23	Boiler exploded	1	2	Jim Thompson	Cotton Gin	Sandersville, Ga.

521	23	4″ steam valve failed			American Printing Co.	Cotton Mill	Fall River, Mass.
522	23	Tube ruptured			Westvaco Chlorine Prod. Co.	Chemical Plant	S.Charleston,W.Va
523	25	Dental vulcanizer exploded		1	Dr. Roy Crane	Dent'l Laboratory	California, Mo.
524	26	Air tank exploded	1	4	Illinois Merchants Tr. Co.	Office Bldg.	Chicago, Ill.
525	27	Hot water supply tank exploded			Joseph Zucker	Residence	Philadelphia, Pa.
526	27	Boiler of silo filling outfit exploded		2	William Schmidt	Farm	Sherwood, Wis.
527	27	Section of heating boiler cracked			Boro School District	School	Beaver Falls, Pa.
528	29	Section of heating boiler cracked			Bellows Falls Trust Co.	Bank	Bellows Falls, Pa.
529	29	Section of heating boiler cracked			Jackson Fence Co.	Fence Works	Jackson, Mich.
530	29	Tube and two headers ruptured			Oliver Iron & Steel Co.	Steel Works	Pittsburgh, Pa.
531	29	Boiler exploded	1	6	Walden & Williams	Saw Mill	Louisville, Ga.
532	29	Boiler of locomotive exploded	3		West Shore R. R. Co.	Railroad	Harbor, N. Y.

MONTH OF OCTOBER, 1922

533	2	Tube ruptured			Armour & Co.	Packing Plant	N. Ft. W., Tex.
534	2	Tube ruptured		3	Indiana Service Corp.	Power Plant	Ft. Wayne, Ind.
535	2	Three headers of power boiler cracked			Consolidated Ice Co.	Ice Factory	Pittsburgh, Pa.
536	4	Tube ruptured		1	Eastern Wisconsin Elec. Co.	Power Plant	Sheboygan, Wis.
537	4	Tube ruptured			City of Lansing	Power Plant	Lansing, Mich.
538	4	Section of heating boiler cracked			State Normal School	School	Athens, Ga.
539	4	Nine headers of power boiler failed			Diamond Alkali Co.	Alkali Works	Fairport, O.
540	4	Tube ruptured		1	Middle West Utilities Co.	Power Plant	Sheboygan, Wis.
541	4	Fitting on 6″ steam line failed		1	Pacific Spruce Corp.	Lumber Mills	Toledo, Ore.
542	5	Instrument sterilizer exploded		2	Dr. F. H. Ritter	Hospital	Pittsburgh, Pa.
543	5	Boiler exploded		3	City of Bellefontaine	Water & Lt. Pl.	Bellefontaine, O.
544	8	Section of heating boiler cracked			Alpha Tau Omega Fraternity	Club House	Columbia, Mo.
545	8	Tube ruptured		1	Memphis Gas & Elect. Co.	Power Plant	Memphis, Tenn.
546	9	Two sections of heating boiler cracked			Buckner School District	School	Buckner, Ill.
547	10	Tube ruptured		2		Lumber Mill	Laona, Wis.
548	10	Two sections of heating boilers cracked			Adirondack Company	Hotel	Lake Placid, N. Y.
549	10	Header cracked			Eastman Kodak Co.	Camera factory	Greece, N. Y.
550	10	Section of heating boiler cracked			Louis M. Potolski	Business Block	Holyoke, Mass.
551	10	Blow off line failed		2	Flanner Steger Land & Lum. Co.	Lumber Mill	Blackwell, Wis.
552	11	Blow off line failed			Flanner Steger Land & Lum. Co.	Lumber Mill	Blackwell, Wis.
553	12	Boiler exploded			N. O. Nelson		Edwardsville, Ill.
554	12	Section of heating boiler cracked			Anna M. Ballinger	Apartment House	Trafford City, Pa.
555	12	Blow off pipe failed			Gordon Lewis	Cotton Gin	Jarrell, Texas

MONTH OF OCTOBER, 1922 (Cont'd)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
556	12	Tube ruptured		1	Bellwill Cotton Mills	Cotton Mill	Wilmington, N. C.
557	12	Several sections heating boiler cracked			Ascher Theatres Corp.	Theatre	Chicago, Ill.
558	12	Five sections of heating boiler burned			Masonic Hall	Office Bldg.	McKeesport, Pa.
559	13	Section of heating boiler cracked			Hampden Lodge No. 27 I.O.O.F.	Lodge Bldg.	Springfield, Mass.
560	14	Section of heating boiler cracked			H. V. Kell Co.	Cold Storage Plt.	Griffin, Ga.
561	14	Section of heating boiler cracked			Margaret J. Wiggins	Stores & Apts.	Springfield, Mass.
562	15	Auto. welded head of rd. sprayer expld.		2	Williams & Libby	Road Contractors	Etowal, Tenn.
563	15	Shell of boiler cracked			Wagnespack & Hydal	Sugar Mill	LaurelGrovePt.,La
564	16	Section of heating boiler cracked			A. B. Candy	Apartment H.	St. Louis, Mo.
565	18	Tube ruptured		4	Botany Worsted Mills	Worsted Mills	Passaic, N. J.
566	19	Heating boiler cracked.			St. Elizabeth School	School	New York, N. Y.
567	20	Boiler exploded	1	1	Harold & Hatcher	Oil Well	Camden, Ark.
568	20	Manifold of heating boiler cracked			Louis Herrup	Store	Hartford, Conn.
569	21	Thresher boiler exploded	1	1	Joe Powell Farm	Thresher Outfit	Burr, Neb.
570	21	Two sections heating boiler cracked			State of Connecticut	Armory	Danbury, Conn.
571	22	Tube ruptured and 74 tubes damaged			Weirton Steel Co.	Blast Furnace	Weirton, W. Va.
572	23	Boiler exploded	1	1	West Point Spoke Co.	Spoke Factory	West Point, Miss.
573	23	Section of heating boiler cracked			Childrens' Aid Society	Childrens' Home	New York, N. Y.
574	23	Section of heating boiler cracked			Gross & Sissarsky	Apartment House	Hartford, Conn.
575	23	Section of heating boiler cracked			Dodson Realty Corp'n.	Business Block	Norfolk, Va.
576	23	Two sections heating boiler cracked			Tom Wye	Knitting Mill	Winchendon, Mass.
577	24	Boiler exploded.	1	2	Ash'y Plane No. 2 C.R.R.of N.J.	Hauling Plant	Wilkes Barre, Pa.
578	24	Fifteen tubes heating boiler cracked			Louis A. Solomon	Apartment House	New York, N. Y.
579	25	Heating boiler exploded			Made Rite Ice Cream Co.	Ice Cream Fcty.	N.Bedford, Mass.
580	25	Six sections heating boiler cracked			Carroll Thomson Company	Auto. Agency	Columbus, O.
581	25	Tube ruptured			Michigan Sugar Co.	Sugar Refinery	Toledo, O.
582	25	Three sections of heating boiler cracked			J. Frank Rolfe	Business Block	Salem, Mass.
583	26	Blow off pipe failed			Frazee Potomac Laundry Co.	Laundry	Washington, D. C.
584	26	Section of heating boiler cracked			School District of Pittsburgh	School	Pittsburgh, Pa.
585	27	Five sections heating boiler cracked			Plaza Realty Company	Theatre	Charleston, W. Va.
586	28	Two sections heating boiler cracked			Board of Education	School	Lawrenceville, Ill.
587	28	Five headers cracked			Kohler Company	Enamel I. Ware	Kohler, Wis.
588	29	Heating boiler exploded		1	St. Paul Episcopal Church	Church	Columbia, Pa.

589	29	Boiler exploded			U. S. Marine Hospital	Hospital	Savannah, Ga.
590	29	Tube ruptured			Michigan Alkali Co.	Mfg. Plant	Ford, Mich.
591	29	Three headers cracked			Estate of Frank W. Andrews	Hotel	Washington, D. C.
592	30	Boiler exploded		1	Southside Tire & Repair Co.	Vulcanizing Plt.	Kansas City, Kan.
593	30	Boiler exploded	1		Clarence Davis	Saw Mill	Waverly, Tenn.
594	30	Tube ruptured			Toledo Sugar Co.	Sugar Refinery	Toledo, O.
595	31	Boiler exploded		1			Detroit, Mich.
596	31	Tube ruptured			B. L. Rhodes	Cider Mill	Chardon, O.
597	31	Blow off pipe failed		1	Lufkin El. Lt. & Power Co.	Power House	Lufkin, Tex.
598	31	Section of heating boiler cracked			School District.	School	New Britain, Conn

MONTH OF NOVEMBER, 1922.

599	1	Three sections heating boiler crkd.			Y. W. C. A.	Y. W. C. A. Bldg.	Portland, Me.
600	1	Eight sections heating boiler cracked			Kyle Building Co.	Apartments	Houston, Tex.
601	1	Blow off pipe failed	1		C. S. Steen & Sons		Abberville, La.
602	1	Boiler of locomotive exploded	1	1	T. & B. V. R. R. Co.	Railroad	Wilmot, Tex.
603	2	Section of heating boiler cracked			M. & F. Meyer	Apartments	New York, N. Y.
604	3	Two sections heating boiler cracked			Bertram W. Frank.	Store	Chicago, Ill.
605	3	Four sections heating boiler cracked			Ramsey Realty Co.	Apartments	New York, N. Y.
606	3	Locm'tive crown sheet bulged and crkd.			Georgia Kaolin Co.	Clay Works	Dry Branch, Ga.
607	3	Two sections heating boiler cracked			Nathan Zahn		Brooklyn, N. Y.
608	4	Tube ruptured			Woodward Iron Co.	Iron Mills	Woodward, Ala.
609	5	Header cracked			Utah-Idaho Sugar Co.	Sugar Plant	Garland, Utah
610	6	Tube in down draft furnace ruptured			Alex Smith & Sons Carpet Co.	Carpet Mill	Yonkers, N. Y.
611	6	Two tubes pulled out and sheets burned			Woodward Iron Co.	Iron Mills	Woodward, Ala.
612	7	Two sections of heating boiler cracked			Crockett Hotel	Hotel	S. Antonio. Tex.
613	7	Boiler of locomotive exploded.			Missouri Pacific R. R. Co.	Railroad	Helena, Ark.
614	8	Header cracked.			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
615	8	Boiler exploded.		1	Yankee Hill Brickyard	Brick Yard	Burnham, Nebr.
616	9	Section of heating boiler cracked			Woodfords Cong. Church	Church	Woodfords, Me.
617	10	Section of heating boiler cracked			Helen F. Bement	Apartments	Terre Haute. Ind.
618	10	Boiler of locomotive exploded		2	Norfolk & Western R. R. Co.	Railroad	Carterton, Va.
619	10	Four sections of heating boiler cracked			Independent Tank Lines, Inc.	Oil Pumping sta.	Mishawaka, Ind.
620	11	Boiler of locomotive exploded	4	3	New York Central R. R.	Railroad	Moreland, N. Y.
621	13	Section of heating boiler cracked			N. Emmons Paine	Garage	Lynn, Mass.
622	13	Two sections of heating boiler cracked			Consolidated Cigar Corp.	Cigar Factory	Traverse City, M.
623	13	Six sections of heating boiler cracked			Wellington Shirt Co.	Shirt Factory	NewBedford, Mass.

MONTH OF NOVEMBER, 1922 (Cont'd)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
624	13	Two tubes ruptured		1	Ebensburg Coal Co.	Coal Mine	Colver, Pa.
625	13	Boiler exploded	2	1	E. White	Saw Mill	Magnolia, Ga.
626	14	Handhole plate blew off			Kentucky & W. Va. Power Co.	Power House	Logan, W. Va.
627	14	Boiler exploded			J. W. Miller Incubator Co.	Incubator Fac.	Rockford, Ill.
628	15	Section of heating boiler cracked			Maine & N. H, Theatre Co.	Theatre	Lewiston, Me.
629	15	Section of heating boiler cracked			Luana Corp'n.	Apartments	New York, N. Y.
630	16	Seven headers failed			Diamond Alkali Co.	Alkali Works	Fairport, O.
631	16	Boiler of locomotive exploded		3	Chicago Great Western	Railroad	E. Stockton, Ill.
632	17	Four sections of heating boiler cracked			Julesburg Heating Co.	Heating Plant	Julesburg, Colo.
633	17	Air tank exploded			H. J. Heintz Corporatoin	Olive Pack. Plt.	Corning, Calif.
634	18	Tube ruptured			Bender Hotel Operating Co.	Hotel	Houston, Tex.
635	18	Twelve headers failed			Diamond Alkali Company	Alkali Works	Fairport, O.
636	18	Manifold of heating boiler cracked			Sacred Heart of Jesus Corp'n.	Orphanage	New Britain, Ct.
637	18	Boiler exploded		4	J. W. Wilder	Saw Mill	Brookville, Ind.
638	19	Tube ruptured			American Public Utilities Co.	Power Plant	Jackson, Miss.
639	20	Flange of head cracked			Harry G. Bartlett	Laundry	Wadsworth, O.
640	20	Header cracked			Harry B. Raffel		New York, N. Y.
641	20	Two tubes pulled out of drum			General Motors Corp'n	Auto. Mfg.	Muncie, Ind.
642	20	Five sections of heating boiler cracked			School Bd. Parish of Calcasien	School	Vinton, La.
643	21	Blow off pipes failed			Palace Model Laundry Co.	Laundry	Detroit, Mich.
644	21	Section of heating boiler cracked			Tobias & Sharbach	Hall	S. Antonio, Tex.
645	22	Tube ruptured			Ind. & Cinn. Traction Co.	Power Plant	Rushville, Ind.
646	22	Section of heating boiler cracked			Estate of Mrs. E. Kampman	Office Bldg.	S. Antonio, Tex.
647	23	Header ruptured			Pittsburgh Plate Glass Company	Glass Factory	Charleroi, Pa.
648	23	Boiler exploded	2	3	Goss Sawmills	Saw Mill	Aragon, Ga.
649	23	Boiler for heating water exploded			Columbia Electroplating Works	Electropltg. Plt.	Columbia, S. C.
650	24	Blow off pipe failed			Palace Model Laundry Co.	Laundry	Detroit, Mich.
651	24	Boiler of locomotive exploded			N. Y. Central R. R. Co.	Railroad	Rhinecliff, N.Y.
652	25	Boiler exploded		3	Riverside Works		Wheeling, W. Va.
653	26	Header ruptured at weld			Narragansett Elec. Lt. Co.	Power Plant	Providence, R. I.
654	27	Welded tube failed			Midwest Box Company	Box Factory	Anderson, Ind.
655	27	Five sections of heating boiler cracked			Gotham Can Company		Brooklyn, N. Y.
656	28	Circulating tube bulged and ruptured			Jacques Kahn Realty Company	Mfg. Plant.	New York, N. Y.

657	28	Six sections cracked			A. B. Hayden	Office Bldg.	Detroit, Mich.
658	28	Two sections of heating boiler cracked			H. A. Metz & Co.	Laboratories	New York, N. Y.
659	28	Heating boiler cracked			A. J. Namm & Sons	Store	Brooklyn, N. Y.
660	28	Boiler exploded		7	Julius C. Burke	Clean. & Dye. Plt.	Chicago, Ill.
661	29	Five headers cracked			School Dist.	School	Monongahela, Pa.
662	29	Two sections of heating boiler cracked			Mt. Oliver School Dist.	School	Mt. Oliver, Pa.
663	29	Six sections of heating boiler cracked			Kyle Bldg. Co.	Apartments	Houston, Tex.
664	29	Boiler of locomotive exploded	1	2	Baltimore & Ohio R. R.	Railroad	Dayton, Ohio.
665	30	Boiler of locomotive exploded	2		Norfolk & Western R. R.	Railroad	Kenova, W. Va.

MONTH OF DECEMBER, 1922

666	1	Six sections boiler ruptured			E. J. Schoettle Company	Paper Box Fcty.	Philadelphia, Pa.
667	2	Two sections heating boiler cracked			Enright Topham Company	Garage	Saginaw, Mich.
668	3	Boiler exploded			Ellzey Well	Oil Well	Jefferson Co., Okla.
669	3	Section of heating boiler cracked			A. W. Peterson & Co.	Leather Factory	Woburn, Mass.
670	3	Two sections of heating boiler cracked			Ramsay Realty Company	Apartments	New York, N. Y.
671	4	Two sections of heating boiler cracked			School District	School	Lincoln, Neb.
672	5	Boiler exploded				Button Factory	Black Rock, Ark.
673	5	Section of heating boiler cracked			Florence G. McKeever		New York, N. Y.
674	6	Two sections heating boiler cracked			Ascher Bros. Inc.	Theatre	Chicago, Ill.
675	6	Three sections heating boiler cracked			H. P. Hood & Sons	Milk Station	Charlestown, Mass.
676	7	Sixteen cylinders on drier exploded		2	Raincheck Umbrellas, Inc.	Umbrella Factory	Lyndhurst, N. J.
677	7	Boiler exploded		1	Chicago & Alton R. R.	R. R. Roundh'use	Venice, Ill.
678	7	Two sections of heating boiler cracked			Windsor Ave. Cong'l Church	Church	Hartford, Conn.
679	7	Fitting on main steam line ruptured			Schovill Mfg. Co.	Brass Factory	Waterbury, Conn.
680	8	Air tank exploded	1	5	S. S. Fitzae	Steamship	Brooklyn, N. Y.
681	10	Heating boiler exploded		10	34 Morton Street	Tenement House	New York, N. Y.
682	10	Fitting on main steam line cracked			Benjamin Moore & Co.	Paint works	Brooklyn, N. Y.
683	10	Section of heating boiler cracked			Wm. M. Lowman		Hastings, Nebr.
684	10	Five sections heating boiler cracked			Arthur H. Carleton	Hotel	Hudson F., N.Y.
685	11	Three sections heating boiler cracked			Inequechan Club	Club House	Fall R., Mass.
686	11	Four sections heating boiler cracked			Koen Bros.	Theatre	Salem, Mass.
687	11	Section of heating boiler cracked			Mrs. N. T. Armigo	Office Bldg.	Albuerque, N. M.
688	11	Safety valve exploded			Pittston Stove Company	Stove Works	Pittston, Pa.
689	11	Tube ruptured			Manville Company	Cotton Mill	Manville, R. I.
690	11	Boiler ruptured			J. S. & Amanda Morris	Laundry	Louisville, Ky.
691	11	Hot water heating boiler exploded			Dr. Isaac D. Kelly	Residence	St. Louis, Mo.

MONTH OF DECEMBER, 1922 (Cont'd)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
	12						
692	12	Three sections heating boiler cracked			Fleming County Farmers' Bk.	Bank Building	Flemingsberg, Ky.
693	13	Section of heating boiler cracked			Missouri Casket Co.	Casket Factory	Kansas City, Mo.
694	13	Heating boiler exploded	2	1	Mrs. W. A. M. Burden	Residence	Mt. Kisco, N. Y.
695	13	Boiler exploded		2	Kelvin Oil Lease	Oil Well	Windfall, Pa.
696	13	Two tubes ruptured			Federal Light & Traction Co.	Power Plant	Walsenburg, Col.
697	13	Five sections of heating boiler cracked			David Halpin	Apartments	New York, N. Y.
698	13	Six tubes ruptured			State of Iowa	Heating Plant	Des Moines, Ia.
699	13	Tube ruptured & eight headers cracked			Fels & Company	Soap Factory	Philadelphia, Pa.
700	13	Two sections of heating boiler cracked			Arthur M. Mathew	Business Block	Flint, Mich.
701	14	Tube ruptured			West Penn. Power Company	Power Plant	Connellsville, Pa.
702	14	Hot water heater exploded		3	A. Priestwood	Residence	Houston, Tex.
703	14	Section of heating boiler cracked			Board of Education	School	N. Bergen, N. J.
704	14	Section of heating boiler cracked			School District	School	Hartville, S. C.
705	15	Crown sheet failed			Gaston Construction Company	Con. Outfit	Clover, S. C.
706	15	Head of air tank ruptured	1		C. Pa. Quarry Strip. & Con. Co.	Coal Mine	Brick Mt., Pa.
707		Section of heating boiler cracked			Forsyth Apartment Company	Apartments	Savannah, Ga.
708	15	Flue of hot water heater collapsed		2	River Crest Club	Club House	Ft. Worth, Texas
709	15	Heating boiler exploded			Passaic-Bergen Lumber Co.	Lumber Yards	E. Orange, N. J.
710	15	Two sections of heating boiler cracked			Ravin & Gordon	Apartments	Lynn, Mass.
711	15	Section of heating boiler cracked			Asa C. Isham	Apartments	Norwood, O.
712	16	Boiler exploded	3	2	George Webb	Saw Mill	Van Buren, Ark.
713	16	Four sections heating boiler cracked			Y. M. C. A.	Y.M.C.A. Bldg.	E. Liverpool, O.
714	16	Tube ruptured			M. Straus & Sons Corp'n.	Leather Factory	Newark, N. J.
715	16	Boiler bulged and ruptured			Mills Mill	Cotton Mill	Greenville, S. C.
716	17	Tube ruptured			I.O.O.F. of Indiana	Lodge & Office B.	Indianapolis, Ind.
717	17	Section of heating boiler cracked			Julesburg Heating Company	Central Ht. Plt.	Julesburg, Colo.
718	17	Tube ruptured			New York Central R. R. Co.	Railroad	Rensselaer, N. Y.
719	18	Heating boiler exploded			Mohr's Coal Company	Coal Yards	Forest Park, Ill.
720	18	Section of heating boiler cracked			Veronica Herberich	Residence	Akron, Ohio.
721	18	Five sections heating boiler cracked			University of Pittsburgh	College	Pittsburgh, Pa.
722	19	Cover of tallow tank blew off			Labor-Light Soap Company	Soap Factory	Denver, Colo.
723	19	Three sections heating boiler cracked			Kleinbreit Realty Corp'n.		New York, N. Y.
724	19	Section of heating boiler cracked			R. N. Filbeck	Hotel	Terre Haute, Ind.

725	20	Boiler exploded			Lyle K. Bosard	Restaurant	Angelica, N. Y.
726	21	Section of heating boiler cracked			American Tel. & Tel. Co.		Denver, Colo.
727	21	Twelve sections heating boiler cracked			Board of Education	Schools	Charleston, Ill.
728	21	Boiler ruptured			Times Publishing Company	Publishing plant	Shreveport, La.
729	21	Section of heating boiler cracked			Consolidated School District.	School	N. Britain, Conn.
730	22	Five sections of heating boiler cracked			Hartford Golf Club.	Club House	W. Hartford, Ct.
731	23	Fitting on 6" steam line ruptured			Crystal Paper Company	Paper Mill	Amanda, O.
732	23	Header on heating boiler cracked			Danville Building Assn.	Office Bldg.	Champaign, Ill.
733	23	Section of heating boiler cracked			Richard Edie, Jr.	Office Bldg.	Yonkers, N. Y.
734	24	Heating boiler exploded			Masonic Temple	Assembly Bldg.	Newcastle, Ind.
735	24	Heating boiler exploded			Citizens' Bank	Bank	Whitewater, Wis.
736	24	Header of power boiler cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
737	25	Steam pipe failed			National Pigments & Chem. Co.	Paint works	St. Louis, Mo.
738	25	Ten sections heating boiler cracked			Meserole Exhibition Company	Theatre	Brooklyn, N. Y.
739	26	Valve on steam heating line ruptured			Max Rosenblatt	Business block	New York, N. Y.
740	26	Section of heating boiler cracked			Grennan Cake Corp'n.	Bakery	Memphis, Tenn.
741	26	Four sections heating boiler cracked			Atkins Company	Stores	Hartford, Conn.
742	27	Portable boiler exploded	2	3	Frank Comly	Saw Mill	Edge Hill, Pa.
743	27	Circulating tube ruptured			Clemetsen Co., Inc.	Mfg. Plant	Chicago, Ill.
744	27	Blow off pipe failed			Southern Cotton Oil Company	Oil Mill	Chicago, Ill.
745	27	Section of heating boiler cracked			First National Bank	Bank Bldg.	Dodge City, Kan.
746	27	Fitting on vacuum pan failed			Utah-Idaho Sugar Company	Sugar Factory	Elsinore, Utah.
747	28	Tube pulled out of drum			Worcester Electric Light Co.	Power Plant	Worcester, Mass.
748	28	Tube ruptured			Estate of Edward Perry	Business block	Philadelphia, Pa.
749	29	Section of heating boiler cracked			Post Publishing Co.	Newspaper plant	Cincinnati, Ohio.
750	29	Header cracked			American Soda Fountain Co.		Boston, Mass.
751	29	Flue collapsed			August F. Coldeway	Creamery	Norwood, O.
752	30	Boiler exploded			Gallipolis Chair Co.	Chair Factory	Gallipolis, O.
753	30	Four sections of heating boiler cracked			Martin M. & Harry Mohl	Business Block	Jamaica, L.I., N.Y.

Item 6 in the Flywheel Explosion List as published in the January 1923 issue of THE LOCOMOTIVE should have read read "Pulley Burst" and not "Flywheel Exploded" at the Burden Iron Company, Troy, N. Y., on February 23, 1922.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1923

Capital Stock, . . . $2,000,000.00

ASSETS

Cash in offices and banks		$532,313.26
Real Estate		255,000.00
Mortgage and collateral loans		1,797,550.00
Bonds and stocks		7,170,021.35
Premiums in course of collection		886,034.35
Interest Accrued		125,956.83
Total assets		$10,766,875.79

LIABILITIES

Reserve for unearned premiums		$4,979,417.54
Reserve for losses		311,286.82
Reserve for taxes and other contingencies		423,444.37
Capital stock	$2,000,000.00	
Surplus over all liabilities	3,052,727.06	
Surplus to Policyholders		**$5,052,727.06**
Total liabilities		$10,766,875.79

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Directors, United States Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.
SAMUEL M. STONE, President, The Colts Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, Vice-President Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, GA.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abell Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	Charles D. Noyes, Chief Inspector.
BRIDGEPORT, CT.,	W. G. Lineburgh & Son, General Agents.
404-405 City Savings Bank Bldg.	A. E. Bonnet, Chief Inspector.
CHICAGO, Ill.,	J. F. Criswell, Manager.
209 West Jackson B'v'l'd	P. M. Murray, Ass't Manager.
	J. P. Morrison, Chief Inspector.
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio,	W. E. Gleason, Manager.
First National Bank Bldg.	Walter Gerner, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chestnutt,
916-918 Gas & Electric Bldg.	Manager and Chief Inspector.
HARTFORD, Conn.,	F. H. Kenyon, General Agent.
56 Prospect St.	A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector.
Hibernia Bank Bldg.	E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y.,	C. C. Gardiner, Manager.
80 Maiden Lane	E. Mason Parry, Chief Inspector.
	R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	Wm. J. Farran, Consulting Engineer.
	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	McCargar, Bates & Lively, General Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
301 Thompson Bldg.	
SAN FRANCISCO, Cal.,	H. R. Mann & Co., General Agents.
339-341 Sansome St.	J. B. Warner, Chief Inspector.
ST. LOUIS, Mo.,	C. D. Ashcroft, Manager.
319 North Fourth St.	Eugene Webb, Chief Inspector.
TORONTO, Canada,	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.
Federal Bldg.	

OCT 11 1923

OF PITTSBURGH, PENNA.

Can Your Fireman Tell

What method of firing gives the best results?

How thick a good fire should be carried?

How many boilers should be used to carry the load?

What should be done first in the case of low water?

What precautions are necessary before connecting a boiler to a steam line which is under pressure?

What tests and observations should be made regarding the operation of a safety valve in every-day operation?

These are only a very few of the questions answered in the Hartford's Correspondence Course for Firemen.

Fill out the blank below and send for further information.

THE HARTFORD STEAM BOILER
INSPECTION & INSURANCE CO.,
HARTFORD, CONN.

Please send me further details of your Correspondence Course for Firemen

Name..

Address..

....

The Locomotive

OF

THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

VOL. XXXV.

PUBLISHED BY
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, CONN.
1924-1925.

INDEX TO VOL. XXXV.—1924-1925

REFERENCE MARKED WITH A STAR (*) ARE TO ILLUSTRATED ARTICLES.

*Account of a Boiler Explosion at Reisholz, Germany, *January 1924,* 11.

*Air Compressor Lubrication, Its Relation to Explosions in Compressed Air Systems, by B. C. Cruickshanks, *April 1924,* 41.

Ammonia Solutions, Data on Aqueous, *July 1925,* 213.

*Ancient Locomotive Still in Service, *October 1925,* 242.

*An Error of Misplaced Confidence, by E. Mason Parry, *October 1924,* 102.

Announcement, Halsey, W. D., appointed Assistant to the Chief Engineer, *January 1925,* 149.

Cruickshanks, B. C., appointed Editor of THE LOCOMOTIVE, *January 1925,* 149.

Announcement, Title page and index for Volume XXXIV, *January 1924,* 20.

Another Autogenously Welded Tank Failure, *October 1925,* 239.

Any "Stray" Bolts in Your Boiler? *October 1924,* 104.

As Vacation Approaches, *July 1925,* 205.

*Autogenously Welded Tank Failures, Jessup & Antrim Co., Indianapolis, Ind., South Side Grocery, Des Moines, Iowa; Auto Accessory Station, Uniontown, Pa.., *January 1925,* 142.

*Autogenously Welded Tank Failure at New Orleans, Maltose Laboratories, Inc., *July 1925,* 207.

Automatic Appliances, by E. H. Vaux, Inspector, *January 1925,* 147.

Bailey, C. B., An Efficient Safety Valve, *July 1925,* 204.

Bayliss, W. A., appointed Chief Inspector of the Boston Department, *April 1924,* 54.

*Boiler Explosion, A Hot Water Heating, at Cleveland, *October 1924,* 98.

*Boiler Explosion, A Hot Water Heating, in a St. Louis Residence, *January 1924,* 2.

*Boiler Explosion at Loreauville, Louisiana, *April 1924,* 51.

*Boiler Explosion at Reisholz, Germany, Account of a, *January 1924,* 11.

*Boiler Explosion, Wolfeboro, N. H., Harry E. Libby Laundry, *Oct. 1925,* 226.

Boiler Explosions, Regular List, January, February, March, 1923, *January 1924,* 22; April, May, June, 1923, *April, 1924,* 58; June, (Cont'd) July, August, September, October, 1923, *July 1924,* 88; October (Cont'd), November, December, 1923, January 1924, *October 1924,* 119; January (Cont'd), February, March, April, 1924, *January 1925,* 150; April (Cont'd), May, June, July, 1924, *April 1925,* 185; August, September, October, November, 1924, *July 1925,* 216; November (Cont'd), December, 1924, January, 1925, *October 1925,* 247.

Boiler Explosions, Summary of, for 1921 and 1922, *July 1924,* 87; for 1923 and 1924, *July 1925,* 215.

*Bolts, Stresses in, Due to Setting Up, *July 1924,* 77.

*Bottom Blowing of Boilers, The, by L.. J. Reed, *July 1925,* 202.

*Buchholz, Charles F., death of, *October 1925,* 246.

Caught in the Separator, "The wisest men that e'er you ken," Twelve Crap Shooters Burned by Hot Pipe as They Dodge Gun, Identifying a Ford, Just Make it a Round Trip, *October 1924,* 115; Cartoon, In the Old Home Town, No Change, Gentle Reminder, *July 1925,* 211; A Little Scotch, Only a Dream, *October 1925,* 243.

Causes and Prevention of Boiler Tube Failures, *April 1925,* 178. .

Changing Over Coal Burning Boiler Furnaces for Oil Burning, *Oct. 1925, 227.*

*City National Bank, Holyoke, Mass., Hot Water Heater Explosion, *October 1925,* 240.

*Compressor, Air, Lubrication, Its Relation to Explosions in Compressed Air Systems, B. C. Cruickshanks, *April 1924,* 41.

Corbin, Elbert A., death of, *October 1924,* 118.

Correction, An Engine Accident at Yale, Michigan, *January 1924,* 19.

Correspondence Course for Firemen, *April 1925,* 179.

Corrosion, *July 1925,* 208.

Corrosion by Acid Water, *January 1924,* 8.

*Criswell, James F., death of, *April 1924,* 53.

Cruickshanks, B. C., *Air Compressor Lubrication, Its Relation to Explosions in Compressed Air Systems, *April 1924,* 41.
  *The Efficiency of Reinforced Tube Ligaments, *January 1925,* 131.
  Appointed Assistant Editor of The Locomotive, *January 1924,* 21.
  Appointed Editor of The Locomotive, *January 1925,* 149.

Data on Aqueous Ammonia Solutions, *July 1925,* 213.

Diesel Engine, double acting, being developed in England, *July 1924,* 66.

*Digester Explosion at Lock Haven, Pa., *April 1925,* 162.

*Droughts and Feed Water, *October 1924,* 98.

*Drying Cylinder, Explosion of a Paper Machine, North Star Strawboard Mills, Quincy, Illinois, *July 1924,* 66.

Ecoff, Asa B., death of, *January 1925,* 148.

Editorials:
  Safety Valves, *January 1924,* 20.
  Air Compressor Lubrication, Its Relation to Explosions in Compressed Air Systems, *April 1924,* 52.
  The Mercury Vapor Boiler and Turbine, *July 1924,* 84.
  Stresses in Bolts Due to Setting up, *July 1924,* 85.
  Droughts and Feedwater, *October 1924,* 116.
  Repairing Vessels While Under Pressure, *October 1924,* 116.
  The Efficiency of Reinforced Tube Ligaments, *January 1925,* 148.
  Notes on the Care and Operation of Electrical Apparatus, *April 1925,* 180.
  Fly-Wheel Explosions Caused by Defective Governors, *July 1925,* 212.
  The Value of Inspections, *October 1925,* 244.

*Efficiency of Reinforced Tube Ligaments, The, by G. H. Stickney and B. C. Cruickshanks, *January 1925,* 131.

Efficient Safety Valve, An, by C. B. Bailey, Inspector, *July 1925,* 204.

Electrical Apparatus, Notes on the Care and Operation of, *April 1925,* 166.

Engine Accident at Yale, Michigan, An, A Correction, *January 1924,* 19.
*Engine Accident, Pumping, at Newark, Ohio, *January 1925,* 130.
*Explosion of a Paper Machine Drying Cylinder, North Star Strawboard Mills, Quincy, Illinois, *July 1924,* 66.
*Explosion of a Rotary Boiler, Lincoln Paper Mills, Ltd., Merritton, Ontario, *April 1925,* 172.
Explosion, A Steam Pipe, *October 1925,* 237.
*Failure of a 2,000 kw. Turbo-Generator, Penick & Ford, Ltd., Cedar Rapids, Iowa, *April 1924,* 34.
*Farran, William J., death of, *October 1924,* 117.
*First Commercial Steam Turbine in This Country, *July 1924,* 75.
*First "Hartford" Inspection, The, *October 1924,* 105.
Fire Routs Owl from Downy Bed in Boiler Box, *April 1925,* 177.
*Fly-Wheel Explosion at Lumberton, Miss., Edward Hines Yellow Pine Co., Lumberton, Miss., Greenville Ice & Fuel Company, Greenville, S. C., *July 1925,* 194.
Fly-Wheel Explosions, Regular List, 1923, *April 1924,* 57; 1924, *April 1925.* 184.
*Foaming and Priming, *July 1925,* 197.
*Gerner, Walter, death of, *July 1925,* 214.
Glennon, William E., appointed Chief Inspector of the Cincinnati Department *July 1925,* 214.
*Greenville Ice & Fuel Company, Greenville, S. C., Fly-Wheel Explosion, *July 1925,* 194.
Guy, Robert P., Safety Valves and Birds' Nests, *October 1924,* 108.
Halsey, Wm. D., *Safety Valves. Inspection and Maintenance, *January 1924,* 3.
  *Safety Valves, Their Application to Pressure Vessels Other Than Boilers, *April 1924,* 35.
  Appointed Assistant to the Chief Engineer, *January 1925,* 149.
*Hines, Edward, Yellow Pine Company, Lumberton, Miss., Fly-Wheel Explosion, *July 1925,* 194.
Horse Power of a Horse, The, *January 1924,* 15.
*Hot Water Heater Explosions, The City National Bank of Holyoke, Mass. and the Irving Hotel, Los Angeles, Cal., *October 1925,* 240.
*Hot Water Heating Boiler Explosion at Cleveland, *October 1924,* 98.
*Hot Water Heating Boiler Explosion in a St. Louis Residence. *January 1924.* 2.
In Retrospect, *October 1925,* 241.
Inspected, Is Your Boiler, *October 1924,* 113.
*Inspection, The First "Hartford," *October 1924,* 105.
*Inspections, The Value of, *July 1924,* 67.
*Inspections, The Value of, Checking Up on Repairs, *January 1925,* 139.
Inspection Statistics, 1923, *April 1924,* 56; 1924, *April 1925,* 183.
Inspector's Warning, It is Well to Heed the, *January 1924,* 17.
*Irving Hotel, Los Angeles, Calif., Hot Water Heater Explosion, *October 1925,* 240.
Is your Boiler Inspected? *October 1924,* 113.
It is Well to Heed the Inspector's Warning, *January 1924,* 17.
*Jessup and Antrim Company, Indianapolis, Ind., Autogenously Welded Tank Failure, *January 1925,* 142.

Jeter, S. F., nominated as a vice president of the American Society of Mechanical Engineers. *July 1924,* 85.
Leary, J. T., Mud-Daubers Hoodwink Inspector, *April 1925,* 176.
Letter from Wisconsin, A, *January 1925,* 138.
*Libby Laundry, Harry E., Wolfeboro, N. H., Boiler Explosion, *October 1925,* 226.
Lighting Boiler Fires, *October 1925,* 232.
Limited Interest, A, *October 1924,* 109.
*Lincoln Paper Mills, Ltd., Merritton, Ont., Explosion of a Rotary Boiler, *April 1925,* 172.
*Locomotive, Ancient, Still in Service, *October 1925,* 242.
*Loreauville Sugar Company, Boiler Explosion at Loreauville, Louisiana, *April 1924,* 51.
*Maltose Laboratories, Inc., New Orleans, La., Autogenously Welded Tank Failure, *July 1925,* 207.
*McMurray, Joseph, death of, *October 1925,* 245.
*Mercury Vapor Boiler and Turbine, The, *July 1924,* 70.
Metric System, The, *April 1925,* 182.
Might Go Either Way, *July 1925,* 213.
Mud-Daubers Hoodwink Inspector, by J. T. Leary, Inspector, *April 1925,* 176.
Murray, Poyntz M., appointed Manager of the Chicago Department, *October 1924,* 117.
*Newark, Ohio, City of, Pumping Engine Accident, *January 1925,* 130.
*New York & Pennsylvania Co., Lock Haven, Pa., Digester Explosion, *April 1925,* 162.
Notes on the Care and Operation of Electrical Apparatus, *April 1925,* 166.
Noyes, Chas. D., death of, *January 1924,* 21.
Obituary Notices:
  *Buchholz, Chas. F., *October 1925,* 246.
  Corbin, Elbert A., *October 1924,* 118.
  *Criswell, James F., *April 1924,* 53.
  Ecoff, Asa B., *January 1925,* 148.
  *Farran, William J., *October 1924,* 117.
  *Gerner, Walter, *July 1925,* 214.
  *McMurray, Joseph, *October 1925,* 245.
  Noyes, Chas. D., *January 1924,* 21.
  Shepley, George L., *October 1924,* 118.
  Spedding, William H., *April 1925,* 181.
Oil Burning, Changing Over Coal Burning Boiler Furnaces for, *October 1925* 227.
*Old Boiler Tubes Used for Lighting Posts, *October 1924,* 110.
*Opening of the Heating Season, The, *October 1925,* 240.
*Paper Machine Drying Cylinder, Explosion of a, North Star Strawboard Mills, Quincy, Illinois, *July 1924,* 66.
*Parry, E. Mason, An Error of Misplaced Confidence, *October 1924,* 102.
*Penick & Ford, Ltd., Cedar Rapids, Iowa, Failure of a 2,000 kw. Turbo-Generator, *April 1924,* 34.

Personal:
  Bayliss, W. A., appointed Chief Inspector of the Boston Department, *April 1924*, 54.
  Cruickshanks, B. C., appointed Assistant Editor of The Locomotive, *January 1924*, 21.
  Glennon, William E., appointed Chief Inspector of the Cincinnati Department, *July 1925*, 214.
  Jeter, S. F., nominated as a vice president of the American Society of Mechanical Engineers, *July 1924*, 85.
  Murray, Poyntz M., appointed Manager of the Chicago Department, *October 1924*, 117.
Pittsburgh's Giant Boiler, *October 1924*, 114.
*Pittsfield Electric Co., Pittsfield, Mass., Steam Turbine Accident, *October 1925*, 236.
*Priming, Foaming and, *July 1925*, 197.
*Pumping Engine Accident at Newark, Ohio, *January 1925*, 130.
*Reed, L. J., The Bottom Blowing of Boilers, *July 1925*, 202.
Repairing Vessels While Under Pressure, *October 1924*, 111.
Research Narratives, Silicon Steel, *January 1925*, 145.
Richest Man in the World, The, *January 1924*, 19.
*Rotary Boiler, Explosion of a, Lincoln Paper Mills, Ltd., Merritton, Ontario, *April 1925*, 172.
Safety Valve, An Efficient, by C. B. Bailey, Inspector, *July 1925*, 204.
Safety Valves and Birds' Nests, by Robert P. Guy, *October 1924*, 108.
Safety Valves, *Inspection and Maintenance, by J. A. Snyder, and Wm. D. Halsey, *January 1924*, 3.
  *Their Application to Pressure Vessels Other Than Boilers, by J. A. Snyder and Wm. D. Halsey, *April 1924*, 315.
Shades of night were falling fast, The, *January 1924*, 18.
Shepley, George L., death of, *October 1924*, 118.
Silicon Steel, *January 1925*, 145.
Sleeping Man Trapped in Firebox as Engine is Fired Up, *April 1925*, 177.
Snyder, J. A., *Safety Valves, Inspection and Maintenance, *January 1924*, 3.
  *Safety Valves, Their Application to Pressure Vessels Other Than Boilers, *April 1924*, 35.
  Radio Talk by, Station KDKA, *July 1924*, 86.
Some After Effects of Welding on Boilers, *July 1925*, 206.
South Side Grocery, Des Moines, Iowa, Autogenously welded tank failed, *January 1925*, 143.
Something Larger, *April 1924*, 64.
Spedding, William H., death of, *April 1925*, 181.
Station KDKA, Radio Talk by J. A. Snyder, *July 1924*, 86.
Steam Pipe Explosion, A, *October 1925*, 237.
*Steam Turbine Accident at Pittsfield, Mass., Pittsfield Electric Co., *October 1925*, 236.
*Stickney, G. H., The Efficiency of Reinforced Tube Ligaments, *January 1925*, 131.
*Stresses in Bolts Due to Setting Up, *July 1924*, 77.

*Stresses in Flat Plates, *October 1925,* 233.
Summary of Boiler Explosions, for 1921 and 1922, *July 1924,* 87; for 1923 and 1924, *July 1925,* 215.
Summary of Inspectors' Work for 1923, *April 1924,* 56; for 1924, *April 1925,* 183.
Tank Failure, *An Autogenously Welded, at New Orleans, Maltose Laboratories, Inc., *July 1925,* 207.
Another Autogenously Welded Tank Failure, *October 1925,* 239.
  *Autogenously Welded, Jessup & Antrim Co., Indianapolis, Ind.; South Side, Grocery, Des Moines, Iowa; Auto Accessory Station, Uniontown, Pa.; *January 1925,* 142.
Transverter, The, *April 1925,* 174.
Tube Failures, Causes and Prevention of Boiler, *April 1925,* 178.
*Tubes, Old Boiler, Used for Lighting Posts, *October 1924,* 110.
*Turbine, First Commercial Steam, in This Country, *July 1924,* 75.
*Turbine, Steam, Accident at Pittsfield, Mass., *October 1925,* 236.
Value of Antique Plate, *July 1925,* 201.
*Value of Inspections, The, *July 1924,* 67.
*Value of Inspections, The, Checking Up on Repairs, *January 1925,* 139.
Value of Inspection Service, The, Can it be Rated in Dollars and Cents? by E. H. Vaux, Inspector, *April 1924,* 51.
*Valve Ruptured by Water Hammer, *October 1924,* 118.
Vaux, E. H., Automatic Appliances, *January 1925,* 147.
Vaux, E. H., The Value of Inspection Service, Can it be Rated in Dollars and Cents? *April 1924,* 50.
  Dollars and Cents? *April 1924,* 50.
Warm Reception, A, *January 1925,* 138.
Water, Corrosion by Acid, *January 1924,* 8.
*Water, Feed, Droughts and, *October 1924,* 98.
Welding on Boilers, Some After Effects of, *July 1925,* 206.

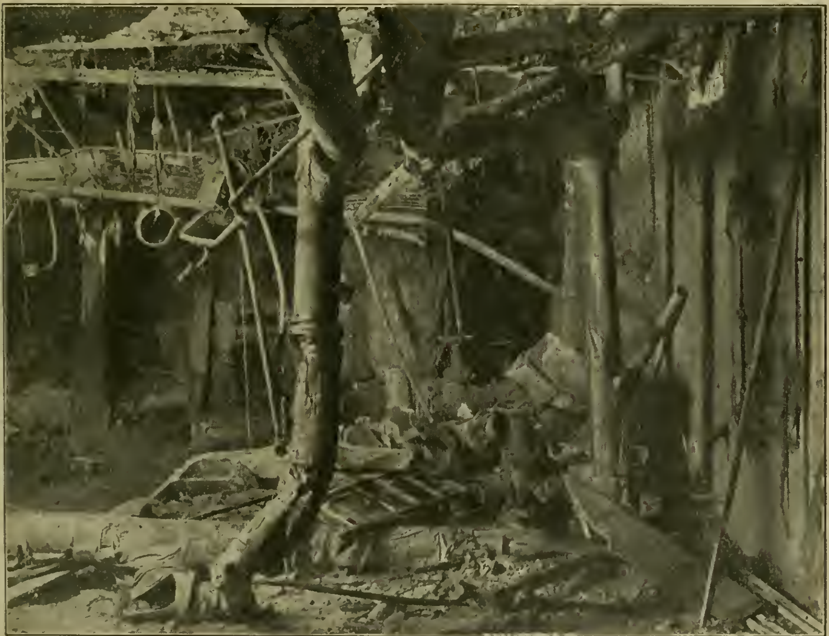
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXV. HARTFORD, CONN., JANUARY, 1924. No. 1.

COPYRIGHT, 1924, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



HEATING BOILER EXPLOSION AT ST. LOUIS.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

A Hot Water Heating Boiler Explosion in a St. Louis Residence.

OUR front cover picture shows some of the damage resulting from one of those explosions that "never happen." The boiler of a hot water heating system in a residence on Portland Place, St. Louis, Mo., exploded with unusual violence not long ago, the resulting property loss being estimated at $20,000.

This picture may give us some idea of the destruction wrought in the basement, but it gives no indication of the violence attained. The boiler was located immediately below the dining-room, and in exploding it blew a hole through the floor and completely wrecked this room. Furniture was tossed about promiscuously, some of it being blown through the ceiling above. All the windows were blown out, one leaded glass window being reported as having traveled thirty feet, while a second floor window was located twenty feet from the house. But perhaps the most significant result of this explosion is the fact that a portion of the brick wall was displaced about two inches.

The exact cause of the explosion cannot be definitely stated in view of the evidence submitted. The hot water boiler was one of a pair, both of which were connected to the same heating system. However, each boiler had a stop valve in the flow line and one in the return line by means of which it could be shut off from the system, leaving the other boiler to do the work. On the day of the accident, the system had been in operation with one boiler on the line, but feeling that the second one was necessary the negro fireman started it up about 10:30 A.M. without looking at the valves. At 12:15 P.M. the boiler exploded.

Investigation after the accident disclosed both the flow and return line valves closed. This would effectually seal off the boiler from the rest of the system and, in the absence of a relief valve, it is easy to foresee the result. It is reported, however, that the valve in the return line was closed by the owner after the explosion to prevent draining the system. Such being the case, the immediate cause of the explosion is not so clear, but the results are quite evident.

With adequate safety appliances, competent operators and a reliable inspection service, many boiler explosions might be avoided. In this particular case a relief valve of proper size and in good working order would probably have taken care of the excess pressure, even though the flow and return valves had been closed. Yet a hot water heating boiler with a proper relief valve is rarely seen, and frequently the direct recommendation of the inspector that such a condition be remedied is met with vigorous objection, the possibility of just such an explosion as this being considered very remote.

As far as we are able to learn, no insurance was carried on this installation.

Safety Valves.

Inspection and Maintenance.

By J. A. Snyder, C. I., Pittsburgh Dept.,
and
Wm. D. Halsey, Editor, The Locomotive.

In the preceding issue of The Locomotive we discussed the subject of Safety Valves from the standpoint of their size, adjustment and installation. It is our intention in the present article to discuss the question of the care and inspection service that a safety valve should receive in order that it may be maintained in as good condition as possible. There may be some repetition of information that appeared in the previous article, but this, we believe, will be pardoned inasmuch as such repetition will be made only for the sake of clearness and in order that each article may be as nearly complete in itself as possible.

When a boiler generates more steam than is required, the pressure will rise unless the excess steam is permitted to escape and it is the function of a safety valve to afford the means of escape when the need arises. In order that the purpose of a safety valve may not be defeated, the steam so discharged must be wasted and therefore it is not in the interest of economy to permit the valve to " blow " too frequently or too long if it can be avoided — although such frequent operation would certainly be an indication that the valve was in working order. Consequently a safety valve is looked upon as an emergency relief which is to operate only when a sudden change in load cannot be taken care of by control of the fire or when the boiler attendants are careless and ignorant. In an attempt to reduce the chance of the safety valve discharging needlessly it has been the practice of some to operate the boiler at a pressure very much below that at which the safety valve will open, with the result that the valve, through disuse, has become inoperative and, when the pressure for some reason has suddenly risen, the valve has failed to open and a disastrous explosion has resulted.

A safety valve should not, of course, be set at a pressure greater than that considered as the maximum allowable for the boiler in question. If the boiler is to be operated at a pressure much below this figure, then the safety valve, in the average case, should be set at not more than ten lbs. above the desired working pressure. This will require close watching by the boiler operator and perhaps the safety valve may "blow" occasionally. However, if this does not occur too frequently or for too long a time, the loss of energy will not be excessive and some assurance will be had that the safety valve is in working order.

Of course, entire dependence should not be had upon the occasional popping of a safety valve brought about by close operation, for routine tests and a positive knowledge and record of the satisfactory operation of a safety valve cannot be replaced by chance occurrence. Valves should be tested in a positive manner daily, if possible, and certainly not less than once a week. The test of a safety valve may consist of raising the steam pressure, causing the valve to blow, and noting the pressures when the valve opens and when it closes. As an alternative, the valve may be raised from its seat by the try lever, it being borne in mind that only a slight effort is required to do this if the steam pressure is close to that at which the valve is supposed to be set. By this method an experienced man can make a very close estimate of the setting of the valve. It will be obvious, however, that the method of raising the steam pressure to "pop" the valve is the more positive of the two. This method, furthermore, enables one to observe the complete action of the valve when in service.

A suggested form for reporting routine tests of safety valves is shown on Page 5. These reports, when any necessary repairs have been completed, should be filed away for future reference, for they would be of great value should any trouble develop.

If, in making tests of the safety valves, the reading of the pressure gauge does not agree with the pressure at which a valve is supposed to blow, do not make any adjustments to the valve without first proving the accuracy of the pressure gauge.

If the releasing pressure of a safety valve is to be changed by one who is unfamiliar with the characteristics of the valve, great caution should be observed. If the setting is to be raised, it is best to make a preliminary test of the valve action by *releasing* the compression on the spring a part turn, say one sixth, of the adjusting bolt, the lock nut first being released (See Fig. 1 on Page 6). The steam pressure may then be raised until the valve blows and by a comparison of the resulting pressure change with the change of the adjusting bolt some idea may be had of how far in the opposite direction it should be turned to increase the compression of the spring and bring about the desired increase in the releasing pressure. When the change of setting has been effected, the lock nut should be tightened and the valve sealed to prevent anyone tampering with it.

Name of Company

City State

SAFETY VALVE INSPECTION REPORT

All safety valves on boilers in operation must be tested on Monday morning —— of each week by raising the steam pressure to the popping point, or by raising each valve from its seat with the try lever. This report is to be signed by the employee making the test. No report shall be filed until all safety valves are in good working order and this fact noted on the report by someone in authority.

Safety Valves on Steam Boilers Nos. 2, 3, 5 and 7 at Plant No 1 were tested by ~~hand~~ steam and found free to blow at the pressures stated except as noted below. Boilers Nos. 1, 4 and 6 were not under steam pressure at time of this test.

Signed Notah Chanco
Boiler Foreman

DATE	BOILER HOUSE	PRESSURES			REMARKS
		OPENED	CLOSED	HAND TEST	
May 7 1923	#2	125	120		Safety valve on # 7 boiler could not be lifted from seat.
8					No. 7 boiler was taken out of service yesterday and new spring placed in safety valve, now works freely at 125# Ike N. Fixit Ch. Engr.

Should a change of setting be found necessary of more than 10% from the pressure for which a safety valve spring is designed, a spring for the new pressure should be obtained from the manufacturer. Screwing down too much on the spring to increase the relieving pressure may bring the coils of the spring too close together for proper operation and operating the valve with a spring not sufficiently compressed is apt to cause chattering.

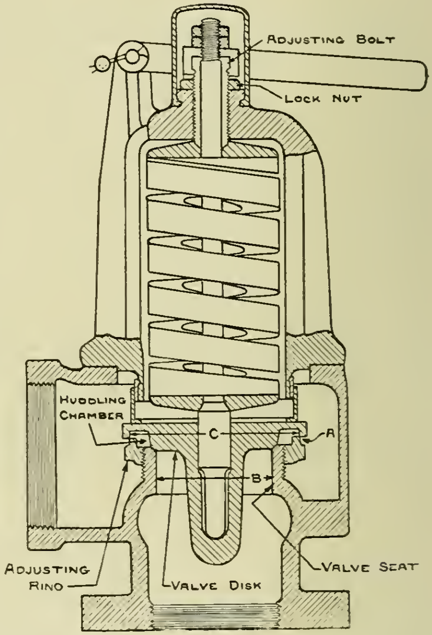


Fig. 1.

The proper amount of blow-down or the difference between the opening and closing pressure of a safety valve varies with the operating pressure. The proposed revision of the A. S. M. E. Code recommends a value for the blow-down of not more than 4% or less than 2% of the operating pressure, the minimum amount for low pressures to be 2 lbs.

These are the maximum values for the amount of blow-down. The valve may be adjusted for a less amount but by so doing the discharge capacity will be reduced, and the life of the valve may be greatly shortened by reason of excessive "wire drawing" of the steam when the valve opens.

If it is found necessary to change the blow-down adjustment, reference should always be had to the instructions issued by the manufacturer or they should be made by someone thoroughly familiar with the proper procedure.

With the adjusting ring (see Fig. 1) held at a given setting, it will be found that any change of the relieving pressure of the valve will cause a change in the amount of blow-down. An increase in pressure will cause an increase in the amount of blow-down and vice versa. Therefore, if the setting of a safety valve is changed it is proper to give some attention to the adjustment of the blow-down.

Chattering of a safety valve usually results from improper installation, although it may be brought about by too small a blow-down. Sometimes a safety valve is installed with several feet of pipe and perhaps several fittings between it and the boiler. When the valve is closed the pressure in this pipe and directly beneath the valve will be the same as that in the boiler. When the valve opens, however, and a flow of steam occurs, the pressure at the safety valve end of the pipe will be less than at the boiler simply because there must be a difference in pressure to cause a flow of any vapor, gas or liquid from one point to another. What this pressure difference will be depends largely on the pressure in the boiler, the opening of the safety valve and the size of the pipe. When such a reduction in pressure occurs it means, of course, that the force acting to open the valve is reduced. If this pressure drop is great enough, the valve will close almost immediately after it has opened. However, as soon as it does close, the flow of steam stops, the boiler pressure is restored throughout the pipe and the valve opens again. It will be readily understood that under such conditions the valve will undergo a fluttering action which is commonly known as chattering. The same action could be brought about by having a long discharge pipe of too small a diameter leading from the safety

A Safety Valve Which Failed to Operate Caused This Explosion. All That Remained of the Boiler House was the Pile of Wreckage Which Extends From the Lower Left Hand Corner of the Picture to the Building Whose Roof was Damaged.

valve. With such an installation there would be atmospheric pressure in the discharge pipe when the valve is closed, but as soon as there is discharge of steam the pressure in this pipe builds up slightly and the valve has to operate against a back pressure. The effect would be the same as a reduction of pressure beneath the valve disc and chattering would result.

It is advisable, therefore, to install safety valves as close as possible to the boiler and if any piping must be used to make it several sizes larger than the valve it serves.

Leakage or, as it is sometimes termed, simmering of safety valves results from several causes. Chips and dirt may lodge themselves between the disc and seat and cause cutting or scoring. The valve parts may " hang up " or stick as a result of corrosion or misalignment. Shoulders may wear at the different points of contact between parts, such as the spindle and the valve disc or " feather," or between the springs and the spring washers, and also on the valve disc and its seat. These shoulders resulting from wear should be removed to permit free and proper action of the several parts, and the moving parts should be lubricated.

It is important, when repairs are made to a safety valve, to hold to the same relation of parts that existed in the original design. This is of utmost importance as regards the valve disc and seat. The disc should come to a bearing with the top surfaces of the disc and seat in the same relation as that for which the manufacturer designed them. Valves having special forms of seat should be returned to the manufacturer for repairs if proper facilities are not at hand to reproduce the original relation of parts.

Corrosion by Acid Water.

IT is a common and not altogether erroneous theory to ascribe all corrosion in boilers to acid water. The term " acid water " might, however, convey a different meaning to different engineers, and some discussion of the term should not be out of place. A water that would ordinarily be called " acid " is one that will give an acid reaction with a common chemical indicator such as methyl orange. Natural waters of this type are rare, and the acidity in such cases can usually be attributed to pollution by industrial waste. Such a water would be very corrosive in boilers, owing to the high solution pressure of iron in acid solution.

The majority of natural waters are alkaline rather than acid, because of dissolved bicarbonate of calcium or other mineral constituents. However, even though these waters are on the alkaline side of neutrality, they all have to a very small degree the principal characteristic of an acid solution; namely, hydrogen ions, which give to the water its power to dissolve iron. An alkaline water is alkaline because it contains free hydroxyl ion, and while all waters contain both hydrogen and hydroxyl ions, they are acid when the hydrogen-ion content is the larger and alkaline when the reverse is true. When the two values are the same, the water is exactly neutral.

Since methyl orange is extensively used by power-plant chemists and engineers for measuring acidity and alkalinity, it is well to emphasize the fact that, while it is very useful in power-plant chemistry, it is poorly adapted for measuring acidity where accurate determinations are necessary in studying corrosion troubles. This is due to the fact that methyl orange changes color slightly on the acid side of neutrality, a fact that is usually overlooked, but is of sufficient importance to be taken into consideration.

The best way of expressing acidity is in terms of hydrogen ions. These ions exist in all waters, including those that are alkaline. At the neutral point the hydrogen-ion concentration is $1/10^7$ grams per liter and the concentration of hydroxyl ions is exactly the same. The product of the two, $1/10^{14}$, remains a constant through the whole range of acidity and alkalinity, so that as one increases the other decreases. Methyl orange changes color when the hydrogen-ion concentration is a little less than $1/10^4$, showing that the concentration is nearly 1,000 times greater at this point than at the neutral point. This discrepancy is not so much as might be supposed, owing to the extremely small concentration at the neutral point, but the difference it represents is enough to make considerable difference in the corrosive power of water.

The writer has frequently come in contact with cases where boiler-feed water was considered safely alkaline, whereas it was found to be slightly acid when measured by methods more accurate than the methyl-orange method. In such cases as these it is important to use accurate methods of measuring acidity and alkalinity and, if conditions justify it, to treat the water with an alkaline substance such as soda ash.

There are two methods of accurately measuring the acidity of water. The more accurate depends on measuring the electric potential of the solution with hydrogen electrode equipment. The other method is much simpler and, while not quite so accurate, gives much more valuable results than the methyl-orange method. Apparatus for this method consists of sealed indicator color standards made from water of different degrees of acidity and alkalinity. With these available, it is only necessary, when testing water, to add a given amount of indicator to the sample and match the color tint with one of the standards.

Iron is soluble in water in proportion to the amount of hydrogen ions present. However, the attack of hydrogen ions on iron does not proceed steadily unless conditions are right. When iron goes into solution, the hydrogen ions in the water are changed to free hydrogen gas. which gives up its electric charge to the iron with the result that the iron becomes polarized, which tends to prevent further action. The solution or corrosion of iron in the average neutral or slightly alkaline natural water is very small and would automatically stop were it not for dissolved oxygen in the water. Unfortunately, all waters contain small amounts of free dissolved oxygen gas from the atmosphere unless the water is specially treated to remove this dissolved gas.

This dissolved oxygen always enters aggressively into the process of corrosion of iron and steel. It unites with the hydrogen liberated by the iron-solution process and prevents the polarization of the iron. It also reacts with the dissolved iron and precipitates it as iron oxide or rust. As the iron is thrown out of solution, more hydrogen ions are simultaneously liberated and the process goes on in cycles, depending on the amount of dissolved oxygen in the water and to a lesser degree on whether the water is acid, neutral or alkaline.

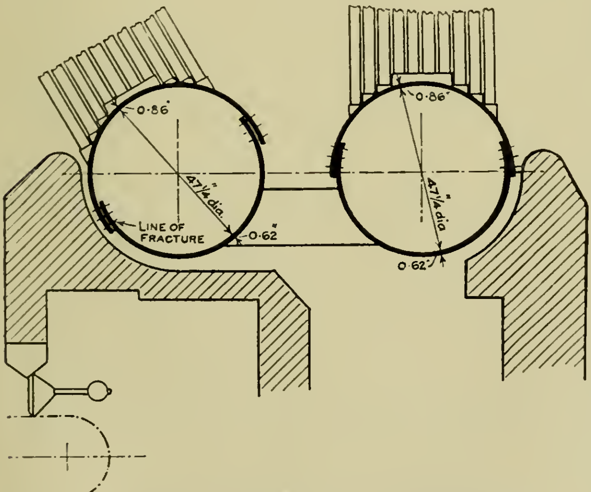
Nature has provided a partial preventive for corrosion by carrying in solution dissolved minerals such as carbonates and sulphates. These settle out on the interior surface of piping and boilers and form a protective coating, which is usually very effective in preventing corrosion However, this natural remedy is such a detriment to heat transfer that its value from the viewpoint of corrosion prevention in boilers is consiberably more than offset by the heat loss it causes. The best and safest method, therefore, of preventing corrosion, is to remove the dissolved oxygen from the water. Apparatus for this purpose is being extensively installed in power plants and hot-water systems.

Distilled water from condensate returns or other sources is more corrosive than natural water because it contains no dissolved minerals to give an alkaline reaction and reduce the hydrogen-ion content. Distilled water also has the capacity for dissolving more oxygen from the air than natural water. A further disadvantage is a slight acid reaction, due to carbon dioxide from the atmosphere. In natural water the carbon dioxide from the atmosphere is usually neutralized by mineral constituents, whereas in distilled water it forms small amounts of carbonic acid, which increases the iron solution pressure. However, distilled water when treated by modern apparatus to remove dissolved oxygen and other gases, including carbon dioxide, furnishes an ideal water supply, and systems of this kind are growing more and more in favor.— *D. H. Jackson in Power.*

Account of a Boiler Explosion at Reisholz, Germany.*

THE central station at Reisholz, situated near Dusseldorf, is one of the largest central stations of the Rhenish-Westphalian Basin. It comprises seven turbines of a total output of 73,000 kw. and 30 boilers with a total heating surface of 18,520 square metres divided into three boiler houses. In No. 3 boiler house, the most recent, there were 12 boilers of the Garbe type working at a pressure of 214 lbs. per square inch, and each having 7,104 square feet of heating surface and 215 square feet of grate area. On the 9th of March, 1920, a little after eight o'clock in the morning, one of these boilers exploded with disastrous violence, killing 27 people and injuring 14 others.

At the time of the explosion eight boilers of this battery were at work, producing about 4.1 lbs. of steam per square foot of heating surface at 199 lbs. per square inch pressure. The working conditions at the time were normal, and there was no apparent cause for the primary rupture which occurred at the front of the riveted longitudinal joint of the lower front drum.



Lower Drums of Garbe Type Boiler.

---

*Reprinted from *Vulcan.*

The two upper drums of the boiler, as well as the two nests of tubes, were projected upwards through the roof. The brickwork, together with the Green's economizer, which was placed behind the boiler, was completely destroyed, and the fragments thrown in all directions.

The dynamic effects made themselves felt on the two boilers on either side, although passages separated these from the boiler which exploded.

That on the right, which was at work, had its fittings completely destroyed, and fell in such a manner that the upper drums rested in the combustion chamber, although no actual explosion of the boiler resulted. The boiler on the left, which was not at work, was, on account of the shock, displaced bodily sideways 8 ft. while some masons who were repairing the brickwork were killed.

The inquiry made by the authorities having eliminated as possible causes of the accident shortness of water, overheating due to deposit, excessive pressure or negligence in working, there only remained to be considered the quality of the plates and the construction of the boiler.

The lower vessel which exploded had a diameter of 47¼ inches composed of two rings connected at mid-length by a butt joint and cover straps with a circumferential riveted seam. Each ring was formed of two half plates, one being bossed out to form the top plate 0.86 inches in thickness, while the lower half was 0.62 inches in thickness. The two longitudinal seams were lap jointed and formed with three rows of rivets.

It was in the left lower half shell ring at the joint turned towards the furnace — from which it was protected by brickwork — that the failure occurred. The seam gave way throughout its length along the line of rivets nearest the over-lap of the tube plate. The principal fracture had a crystalline appearance, and showed signs of further minute fractures, which started at the rivet holes and radiated like lines of force towards the solid plate and from one rivet hole to another. These radiating fractures seemed to indicate that the plate was brittle. Specimens of the fractured plate, as well as the plate of the right half of the drum, which remained intact, were submitted to machine tests, with the following results: —

The two plates showed a tensile strength of 21.58 to 26 tons per square inch and an elongation below 25 per cent in the case of the specimens as submitted, though after annealing a higher elongation than 25 per cent was obtained. Shop tests on notched bars showed the two plates to be very brittle, both in the neighbourhood of the riveting and in the solid plate, but this brittleness was more accentuated in the plate that failed than in that from the other drum. This brittleness, however, disappeared after annealing. Chemical and mycrographic analyses did not reveal any particular defect that explained this brittleness, nor did the tests indicate whether the brittleness was produced in the rolling of the plates or in the making of the boiler. The phosphorus content was found equal to 0.054 per cent.

Whilst the debris was being removed after the explosion, an incident occurred which confirmed the brittleness of the plates. A girder fell from the roof upon some of the plates, causing the latter to break like glass, and a piece as large as the hand to be detached without any deformation. A further fact may also be noted. About 11 months before the explosion a crack occurred in another boiler of the same battery in the same position as the primary rupture in the exploded boiler whilst a hydraulic test was being carried out after some leaking rivets had been caulked. The plate that fractured on that occasion had been found to be brittle, but, as a micrographic examination and a chemical analysis did not give unfavorable results, it was thought that the brittleness was due to defective heat treatment or to work being carried out in the boiler shop on the plate at too low a temperature. After the explosion it was discovered that the plate which caused the explosion came from the same batch as the plate which failed 11 months before under hydraulic test.

Laboratory investigations having failed to furnish any complete explanation, one is reduced to hypothesis as to the cause of the brittleness which led to the explosion. The probable cause appears to be one of the following: (1) That the plates had been rolled at too low a temperature without subsequent annealing: or (2) annealed at too low a temperature; or (3) that after annealing the plates had been piled one on the other, with the result that the cooling was too slow. These hypotheses find some justification in the fact that the plates were made during the war at a time when all forges were hard pressed, and when it was not possible to give normal care to manufacture.

But if the brittleness of the plates is accepted as the primary cause of the explosion, it is certainly not the only one, as the construction of the boiler is not free from criticism. When dealing with large diameters and high pressures, it is always advisable to avoid lap-joints and employ butt-joints at the riveted seams. The latter form of joint permits the shells to take a truly cylindrical form, and avoids the deformations which must inevitably occur when lap joints are used. These slight departures from true circular form, due to the use of lap-joints, are the more objectionable when two different thicknesses of plate are riveted together, as was the case with the exploded drum. The greater rigidity of the top plate of the drum, due not only to its increased thickness but also to the bossing of the tubes, transmitted to the lower and thinner plate all the deformation, and consequently it was in the line of attachment of the thin plate that the stresses brought into play by changes of form were most localised. The cracks starting from the rivet holes lead one to suspect that the metal has been stressed beyond its elastic limit either by too heavy "flogging" of the edges of the plates when the boiler was being constructed or by the use of too high a pressure in the hydraulic riveting machine. It is known that hydraulic-riveting, whilst having considerable advantages over hand-riveting, presents this special danger, and can set up cracks starting from the rivet holes if too high a pressure is used. Tests made before the war have shown that this risk exists if a pressure higher than 51 tons per square inch of section of rivet is used. Whilst inquiries do not reveal any fault in the method of working of the boiler which could be held directly responsible for its failure, it is nevertheless deserving of notice that since its installation a short time previously the boiler had been repeatedly tested by hydraulic pressure following tube replacements. It is very possible that these repeated tests — made each time at an increase of 71 lbs. over the working pressure, that is with a test pressure of 284 lbs. on the inch — may have aggravated existing minute cracks, without leading to a complete rupture of the riveted seam, and was actually found to be the case with one of the neighboring boilers.

The preceding considerations show how greatly the safety of boilers, particularly those of large size and high pressure, depend upon little details of manufacture, such as the care given to annealing, the pressure of the riveting machines, the bending of the edges of the plates, etc., and how necessary it is not only to be sure that the materials employed are of good quality, but that in their use every care is taken to avoid injury by defective workmanship or ill-treatment. Anything which tends to make plates brittle or creates incipient fractures is a potential source of danger, and may, as in the present case, result in disaster. The riveted joints for high-pressure boilers, it may be also observed, should be made with butt-joints and double cover-straps. Lap joints particularly with plates of different thicknesses, should be absolutely prohibited.—*Associations Françaises de Propriétaires d'appareils à vapeur.*

Although the statement is made in the above article that the use of riveting pressures greater than 51 tons (presumably the English value of 2240 lbs.) per square inch is attended with risk, this is not borne out in American practice. It is accepted as good practice in the United States to use pressures of 100 to 150 tons (2000 lbs.) per square inch of rivet area (based on the cold rivet before driving) and, so far as we can learn, no deleterious effects have been traced to the use of such pressures.

From a review of the facts presented above it is our opinion that faulty material was the principal cause of the accident. There is a possibility that the use of an hydraulic test pressure equivalent to 133% of the working pressure may have contributed to the failure because of the presence of faulty material. However, the use of test pressures of 150% of the working pressure is accepted good practice in the United States and, when applied to a properly constructed boiler, we see no reason to question such use.—*Editor.*

The Horse-Power of A Horse.

HOW big is a horse-power? If this question were asked you, how would you answer it? Some of us no doubt have previously formed some idea of the size of this unit in one of several ways. Perhaps, being familiar with the definition, we have attempted to visualize doing 33,000 foot-lbs. of work per minute, a unit originated by James Watt. Perhaps we have thought of it only in terms of comparative engine sizes. But if no preconceived idea had been formed as to the size of a horse-power, it is quite likely that recourse would be had to the origin of the term, the power developed by a horse. In this comparison of the mechanical and animal units we will not attempt to say whether or not Watt's "good London draught-horse" was the equal of an Iowa horse, yet according to experiments conducted at the Iowa State Fair in August, 1923, pairs of horses developed, for short periods of time, from 8 to 21 mechanical horse-power, or from 4 to 10 mechanical horse-power apiece.

These figures were obtained as a result of a " Horse and Mule Pulling Contest " held jointly by the Iowa State College and the Horse Association of America, the object of the contest being to develop machinery and methods which would furnish a true comparison of draft animals.

To the man of mechanical turn of mind, the most interesting thing connected with these tests is the dynamometer invented for the purpose by Mr. E. V. Collins of the Iowa State College. Quoting from Leaflet 97 of the Horse Association:—

" Like all epoch making inventions, the Collins horse and mule dynamometer is exceedingly simple. In appearance it is much like a wagon. It utilizes the principle of hydraulics. Weights of the desired amount are suspended in mid-air while the horses are pulling. The wagon cannot move forward until the weights are lifted, for as long as the weights are down a valve is closed and the wheels are locked by hydraulic pressure. As soon as the horses exert enough power to raise the weights, the valve opens and the wheels are releasd. The apparatus requires exactly the same draft whether being drawn uphill, downhill or on the level, over a ploughed field or on a smooth hard road surface. The horses must expend more energy in moving their own bodies up hill than on the level, but the pull on the machine remains constant, and may be set at any predetermined load desired."

One of the interesting results of these tests is a direct comparison of the effect of various road surfaces on the pull required to transport a load. It was found that a pull of 32.5 lbs. per ton was required on a concrete pavement, 51.8 lbs. per ton on a brick pavement, 77.7 lbs. per tons on asphalt and 134.7 lbs. per ton on a dirt and cinder surfaced road. These results, corroborated by other tests, show that it is easier to pull three tons on a concrete road than one ton on a firm dirt road.

The pulling power of the various teams was found to be largely governed by their weight, training and gameness.

" While no final conclusions can be drawn until thousands of pairs of horses and mules have been tested, the Iowa State Fair tests were sufficient to show that the value of weight has not been overemphasized. True pulling lightweight teams were able to start almost as heavy loads as the heavier horses, but they were not able to carry them the required distance and the tremendous effort which they were obliged to exert showed that they would soon be too exhausted to start such a load.

" The tests developed also that the skill with which the teams were broken to pull had a very large bearing. There were horses in the test that were game to the core, willing to settle into their collars and stay there until told to stop, even on loads that they could not move. There were other horses that quit. Men have encountered this same thing in race horses and it is reasonable to conclude that gameness — the never-die spirit — is one of the big assets of a draft horse.

"A spectacular example of gameness was given by the little broncho team which weighed 455 pounds less than any of its competitors, but which pulled larger loads in proportion to weight than any team entered in the test in any class. Through sheer nerve and extreme muscular effort they successfully exerted every pull required up to 2,000 pounds and pulled even this for 40 feet. The same characteristic was shown by a pair of grade Shires, owned by the Des Moines Ice & Fuel Company. They were able to start a load as heavy as any team in their class and never quit, although they did not have sufficient weight to carry the load the required distance. The big team of Taft & Co. was equally as game and the advantage of weight was clearly evident, as they made every pull on the first trial, which no other team was able to do.

"It is a matter of regret that no mules were entered because it has often been claimed that mules can pull more for their weight than horses. Further tests will determine whether this is true."

The large reserve capacity of a team was ably brought out in these tests, and this is felt to be one of its most valuable assets. In the work of hauling it is evident that although the average pull required to move a load may not be great, yet on occasions several times this pull may be necessary to keep the load moving. It was demonstrated that the reserve power of a team of horses is six or seven times its normal working load.

It is also expected that the Collins Dynamometer will provide a valuable method for the selection and development of draft horses.

It Is Well to Heed the Inspector's Warning.

ONE of our Inspectors, on making a visit to a certain plant, noted the condition of the engine which, by the way, we did not insure, and called the Engineer's attention to the fact that the governor would not give proper protection against the hazard of a flywheel explosion. The Engineer remarked that he "'lowed it was tol'able safe to run for a spell yet and that he was keeping a right smart watch on it."

In the local newspaper a few days later there appeared the following news item giving an account of the wrecking of this fly wheel:

> "A broken governor belt on the main driving engines of the ——— Coal Company at ——— Saturday morning endangered the lives of several men, including the engineer and superintendent of the company, and resulted in the demolition of the power house.
>
> "Reports of the accident indicate that the swiftly revolving steam governor was struck in some manner, the small driving belt breaking instantly with the result that the main driving engines ran wild demolishing the huge driving wheel and in turn the power house.
>
> "The bursting flywheel, said to have been 15 feet in diameter. not alone wrecked the building housing it, but pieces of it were hurled against the 75 foot steel smokestack which collapsed. It is declared a miracle that none were injured as huge pieces of steel and iron were hurled in every direction.
>
> "The president of the company reported that the speed of the machinery developed so fast that it was impossible to cut off the power before the crash came. The building will be rebuilt at once."

Apparently, when the governor belt broke, the governor failed to to release the valve gear and this was the very condition that the Inspector feared might be brought about. As a result the engine overspeeded and the wheel burst. The estimated damage to the property amounted to $5,000. Fortunately, no one was injured.

A Correction.

In the article entitled "An Engine Accident at Yale, Michigan," on page 240 of the October, 1923, issue of The Locomotive, reference was made to a piece of flywheel as weighing 50 tons. The weight should have been stated as 50 pounds.

The shades of night were falling fast,
The fool "stepped on it" and rushed past.
A crash — he died without a sound;
They opened up his head and found — Excelsior !

— *Boston Transcript.*

The Richest Man in the World

Answering an editorial in the Norfolk, Neb., *Daily News*, Edward J. Myers, the village blacksmith of Pierce, Neb., was stirred to pen the following letter to the editor of that paper.

"I wonder if you knew that one of the richest men in the world was fourteen miles north of Norfolk, right here in Pierce, Neb.? That man is the writer. I am just a common 'Plug Blacksmith,' but oh — how rich! I go to my labors each morning, work until noon, go to dinner, return at 1 P. M., and work till 6 o'clock. I enjoy the greatest of all blessings, good health. Rockefeller would give all he possesses in money or holdings for my stomach, but he can't have it.

"Each day sees something accomplished and every job of work I turn out, I feel that I have done my customer a service 'worthy of my hire.'

"I have a most wonderful little wife. She has stuck to me twenty-two years now, so I know she must be a dandy to accomplish that. I have a little home, a beautiful little daughter, a son grown to maturity, and now in life's game for himself. Rich? Why, man alive, who can possibly be richer? Then, to add to all the above riches, I take down my old shotgun in season and ramble thru fields, woods and tangle in search of the elusive cotton-tail, teal and mallard with my faithful old pointer at 'heel' (now past 11 years old) and he is as happy as I when on the hunt. Then, when I get back, oh — how good everything does taste. Then, when night has spread its mantle over this good old universe, I settle down in a good old easy chair, enjoy a smoke and then roll into bed to be embraced by 'Morpheus' and never hear a sound until the beautiful break of another day. Rich? Did you say? Well, I guess! $'s? no, not many. You inquired about RICHES; not material wealth.

"The height of my ambition is to so live that I may have no regrets for having lived, when the time comes for me to shuffle off this mortal coil, and I hope by that time to have accumulated just enough $'s, so that myself and mine may not be objects of charity.

"This, then, is my idea of a rich man. If anyone enjoys life more than I do, he is to be envied for his riches.

"With kindest regards,

"EDW. J. MYERS."

The Locomotive

DEVOTED TO POWER PLANT PROTECTION
PUBLISHED QUARTERLY

WM. D. HALSEY, Editor. B. C. CRUICKSHANKS, Assistant Editor.

HARTFORD, JANUARY, 1924.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

IN this issue of THE LOCOMOTIVE there appears the second installment of the article on Safety Valves. The first installment was published in the October, 1923, issue and dealt particularly with the size, adjustment and installation of such valves; the present issue deals with the care and inspection service that safety valves should receive.

Regular and frequent inspection of safety valves should be the rule in every plant, large or small. Although the modern pop safety valve is a well constructed device, it may become inoperative through disuse or through failure to keep the parts in proper condition. We strongly recommend that after every inspection of the safety valves a written report be made to someone in responsible charge of the plant on the condition of the valves and of any repairs that were made or are necessary. A suggested form for this report will be found on page 5 of this issue of THE LOCOMOTIVE.

The title page and index for Vol. XXXIV of THE LOCOMOTIVE, covering the years 1922 and 1923, is now available and may be obtained upon application to the Hartford Office of the Company.

Personal.

We take pleasure in announcing the appointment, effective January 1, 1924, of Mr. B. C. Cruickshanks to the position of Assistant Editor of The Locomotive.

Mr. Cruickshanks has had several years of practical experience at the U. S. Bureau of Standards. He is a graduate of George Washington University, Washington, D. C., and for three years prior to his coming with this Company he taught in the mechanical engineering department of that institution.

Since his coming with this Company in July, 1923, Mr. Cruickshanks has been the Director of our Correspondence Course for Firemen, and has given some assistance in the work of issuing The Locomotive. In his new position he will continue to have charge of the Correspondence Course and he will also be more closely identified with The Locomotive, preparing articles for publication and assisting in the details connected therewith.

Obituary.

Mr. Charles D. Noyes, Chief Inspector of our Boston Department, died suddenly at his home in Wellesley Hills, Mass. on Monday, November 19, 1923. Apparently in the best of health, Mr. Noyes had put in a busy day at the office without complaining of feeling ill, and his death came almost without warning after he had retired for the night.

Mr. Noyes was born February 10, 1853, at Woodstock, Maine. Educated in the town and high schools, he later acquired an unusually wide experience along mechanical lines, having worked as a machinist and in an engineering capacity for several New England railroads.

Mr. Noyes joined this Company's organization as an Inspector July 3, 1895. He later became Supervising Inspector, and in May, 1915, was appointed Chief Inspector of the Boston Department, which position he held at the time of his death.

Of very congenial disposition, fairminded in his dealings with men, and gentlemanly in all his actions, Mr. Noyes was held in high esteem by his own men as well as by the many assured with whom he came in contact.

He is survived by his wife, a daughter, Mrs. W. R. Amidon of Wellesley, and a son, Walter D. Noyes of Waban.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JANUARY, 1923.

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	1	Four sections heating boiler cracked			Samuel Y. Thompson	Mfg.	Philadelphia, Pa.
2	2	Two sections heating boiler cracked			Board of Public Education	School	Pittsburgh, Pa.
3		Two sections heating boiler burst			County of Union	Court House	Union, S. C.
4		Tube ruptured			H. H. Sheip Mfg. Co.	Woodworking	Philadelphia, Pa.
5		Blow off pipe failed			Southern Cotton Oil Co.	Oil Mill	Chicago, Ill.
6		Section heating boiler cracked			School District of Mt. Oliver	School	Mt. Oliver, Pa.
7		Two sections heating boiler cracked			Julesburg Heating Co.	Heating Plant	Julesburg, Colo.
8		Boiler exploded	1		Mose Lovett	Saw Mill	Seminole, Ga.
9		Boiler exploded			Lee & Holden	Shoe Shop	Memphis, Tenn.
10	3	Tube ruptured			Alex. Smith & Sons Carpet Co.	Carpet Mill	Yonkers, N. Y.
11		Four sections heating boiler cracked			Rose Rudinsky	Apartment House	New York City.
12		Two sections heating boiler cracked			School Trustees of Odell Twp.	School	Odell, Ill.
13		Section of heating boiler cracked			Board of Education	School	Glens Falls, N. Y.
14		Blow off pipe failed		1	J. W. Davis Co.	Greenhouse	Terre Haute, Ind.
15	4	Section of heating boiler cracked			Sophia Katz		Danbury, Conn.
16		Six sections heating boiler cracked			Crebe Hotel Co.	Hotel	St. Louis, Mo.
17	5	Two sections heating boiler cracked			Estate of John M. Galt	Bank Building	Sterling, Ill.
18		Heating boiler exploded			Max Faucett	Residence	Indianapolis, Ind.
19		Heating boiler exploded			Merchants & Farmers Bank	Bank	Dansville, N. Y.
20	6	Two sections of heating boiler cracked			I. Miller & Co.	Warehouse	Sioux City, Ia.
21		Three sections of heating boiler cracked			Ellen J. T. Orr,	Garage	Newtonville, Mass.
22		Section of heating boiled cracked			Columbia Hotel Co.	Hotel	Columbia, Mo.
23		Boiler exploded			Crow Fountain Lumber Co.	Saw Mill	Kountze, Tex.
24	7	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
25		Two sections heating boiler cracked			Canfield Oil Company	Oil & gasoline	Cleveland, Ohio.
26	8	Two sections heating boiler cracked			Sweeten Automobile Co.	Garage	Philadelphia, Pa.
27		Two sections heating boiler cracked			Chase Companies, Inc.	Manufacturing	Waterbury, Conn.
28		Heating boiler exploded		2	High School	School	Fultonville, N. Y.
29	9	Section heating boiler cracked			Isaac Richmond	Garage	Springfield, Mass.
30		Tube ruptured		2	Baylor Hospital	Hospital	Dallas, Texas

31		Section heating boiler cracked			Chismore Apartments	Apt. House	San Francisco, Cal.
32	10	Section of heating boiler cracked			Exchange National Bank	Business Block	Hastings, Nebr.
33		Three sections heating boiler cracked			Jane I. Ordway	Stores & Offices	Lawrence, Mass.
34		Boiler bagged and ruptured			Rio Grande Oil Company	Oil Refinery	El Paso, Texas.
35		Air tank exploded		1	Dixon & Langhrey	Garage	Uniontown, Pa.
36	11	Head of boiler burst			Belcher Steam Laundry Co.	Laundry	Palestine, Tex.
37		Heating boiler exploded			928 Crescent Street	Apartment House	Chicago, Ill.
38	12	Failure of nipple in heating boiler			States Electric Co.	Elec. Service Co.	Omaha, Neb.
39		Two sections heating boiler cracked			D. A. Cushman Realty Company	Apartment House	New York City.
40		Heating boiler exploded			Daniel Deegan	Residence	Geneva, N. Y.
41		Boiler exploded	1	1	Morris Saw Mill	Saw Mill	New Bern, N. C.
42		Boiler exploded	1	2	Elbert Bentley Mill	Grist Mill	Jackhorn, Ky.
43	13	Section of heating boiler cracked			Samuel Posner	Apartment House	Rochester, N. Y.
44		Two sections heating boiler cracked			Congregation Beth Hamedrosh	Synagogue	Brooklyn, N. Y.
45		Five sections heating boiler cracked			University of Pittsburgh	College	Pittsburgh, Pa.
46		Tube ruptured			Carr-Ryder-Adams Company	Sash Factory	Dubuque, Ia.
47		Two sections heating boiler cracked			S. J. Cordner Co., Inc.	Garage	Springfield, Mass.
48	14	Four sections heating boiler cracked			L. Needles-Booker Company	Shirt Factory	Philadelphia, Pa.
49	15	Section of heating boiler cracked			Central Iowa Bldg. Corp.	Office Bldg.	Des Moines, Ia.
50		Non-return valve burst			Armour & Company	Packing House	E. St. Louis, Ill.
51		Boiler ruptured			Tremont Lumber Company	Lumber Mill	Rochelle, La.
52		Blow off pipe failed			Illinois Women's College	College	Jacksonville, Ill.
53		Tube ruptured			American Manufacturing Co.	Mfg. rope	Philadelphia, Pa.
54		Boiler of locomotive ruptured		2	C. R. I. & P. R. R.	Railroad	Carthage, Ark.
55	16	Section of heating boiler cracked			Washer Brothers	Dry Goods Store	San Antonio, Tex.
56		Section of heating boiler ruptured			T. K. Givens	Apartment House	Louisville, Ky.
57	17	Section heating boiler cracked			A. Manual Welinsky		New Britain, Conn.
58		Steam separator ruptured			Laundry Service Company	Laundry	Salt Lake City, U.
59		Fire sheet ruptured			Barcalo Mfg. Co.	Mfg. Beds	Buffalo, N. Y.
60	18	Three sections heating boiler cracked			Bethany Evang. Lutheran Church	Church	Pittsburgh, Pa.
61	19	Section heating boiler cracked			School Dist. of Mt. Oliver	School	Mt. Oliver, Pa.
62		Fire sheet bulged and ruptured			Barcalo Mfg. Co.	Mfg. Beds	Buffalo, N. Y.
63	20	Tube ruptured			Middle West Utilities Co.	Power House	Harrisburg, Ill.
64		Section of heating boiler cracked			Weir Stove Company	Stove Foundry	Taunton, Mass.
65		Section of heating boiler cracked			20 Morningside Ave. Corp.	Apartment House	New York City.
66		Compressed air pipe exploded			Weirton Steel Company	Coal Mining	Republic, Pa.
67		Two sections heating boiler cracked			Snead & Co.	Iron Works	Jersey City, N. J.
68		Heating boiler exploded			First Christian Church	Church	Davenport, Ia.
69		Boiler ruptured			Sam Bell	Saw Mill	Moncks Cor., S. C.

MONTH OF JANUARY, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
70	21	Stay bolts pulled out of crown sheet			MacDougal Construction Co.	Asphalt Plant	Atlanta, Ga.
71		Boiler of locomotive exploded	3		Southern Railway	Railroad	Inlet, Va.
72	22	Tube ruptured			Woodward Iron Company	Blast Furnace	Woodward, Ala.
73		Tube ruptured		1	Southern Cotton Oil Company	Edible Products	Bayonne, N. J.
74		Ten headers cracked			By-Products Coke Company	Alkali Mfg.	Chicago, Ill.
75		Section of heating boiler cracked			City of Dyersburg	City Hall	Dyersburg, Tenn.
76		Ten tubes pulled from drum			Continental Paper & Bag Co.	Paper Mill	Oconto Falls, Wis.
77	23	Boiler bulged and ruptured			Sherwood Bros. Co.	Bristol Ware Mfg.	New Brighton, Pa.
78		Twelve tubes pulled out of drum	3		Midwest Refining Company	Oil Refinery	Salt Creek, Wy.
79		Two sections heating boiler cracked			Benj. F. English	Mercantile	New Haven, Conn.
80		Boiler exploded	2	1	Midwest Refining Co.	Oil Well	Casper, Wyo.
81	25	Boiler exploded		1	East Wash. St. Filling Sta.	Vulcanizing Plant	Greenville, Ga.
82	26	Tube ruptured			Monsanto Chemical Company	Chemical Works	St. Louis, Mo.
83		Boiler bagged and ruptured			L. A. Greenlaw	Laundry	Sonora, Calif.
84		Boiler exploded			Pratt's Sawmill	Saw Mill	Houston, Texas.
85	27	Heating boiler cracked			Chippewa Printery	Printing Shop	Chippewa, Wis.
86	28	Section of heating boiler cracked			Union School Dist. of Saginaw	School	Saginaw, Mich.
87		Five sections heating boiler cracked			Philjean Realty Corp.	Office Bldg.	New York City.
88		Tubes ruptured and headers cracked			Mary Machson	Apartment House	New York City.
89		Boiler of locomotive exploded	2	2	Pennsylvania Railroad	Railroad	Chicago, Ill.
90	29	Section heating boiler cracked			Sheridan County, Wyoming	County Jail	Sheridan, Wyo.
91		Section of heating boiler cracked			Rotter & Speer Co.	Junk Yard	Cleveland, Ohio.
92		Five sections heating boiler cracked			Danville Bldg. Assn.	College Dormitory	Champaign, Ill.
93		Heating boiler ruptured			Christian Church	Church	Washington, Ia.
94		Boiler of locomotive exploded		3	C. R. I. & P. Railroad	Railroad	Minneola, Kan.
95	30	Tube ruptured and headers cracked			L. & W. Valley Pr. Co.	Power House	Scranton, Pa.
96	31	Boiler exploded			Ben M. Davidson	Saw Mill	Monticello, Ga.
97		Section heating boiler cracked			Swedish Evang. Mission Cong. Church	Church	Bridgeport, Conn.

MONTH OF FEBRUARY, 1923.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
98	1	Six sections heating boiler cracked			Helen L. G. Asinari	Apartment House	New York City.
99		Header failed			Agasote Millboard Co.	Millboard products	Trenton, N. J.

100		Four sections heating boiler cracked			Board of Education, Dist. No. 1	School	Glens Falls, N. Y.
101		Fitting on feed water line ruptured			Mass. Cotton Mills	Cotton Mill	Boston, Mass.
102		Accident to heating boiler			Junior High School	School	Springfield, Utah.
103		Two sections heating boiler cracked			J. S. Doane	Hotel	Bryan, Texas.
104	2	Accident to boiler			Badger Candy Company	Candy Factory	Milwaukee, Wis.
105		Four sections heating boiler cracked			E. & C. A. Cook	Leather Curing	Salem, Mass.
106		Section heating boiler cracked			Englander Spring Bed Co.	Bed Mfg.	Brooklyn, N. Y.
107		Boiler exploded			Rust & Reece	Saw Mill	Chaviers, Ala.
108		Boiler of locomotive exploded				Railroad	Louisburg, Kans.
109		Boiler of locomotive exploded	3		Huie Hodge Lumber Co.	Saw Mill	Hodge, La.
110	3	Three sections heating boiler cracked	1	2	Columbia Theatre	Theatre	Alliance, Ohio.
111		Water-back of kitchen range exploded			Mrs. Thyra Modene	Residence	Duluth, Minn.
112		Section of heating boiler cracked			A. B. Banks	Residence	Fordyce, Ark.
113	5	Section of heating boiler cracked			Keystone Warehouse Co.	Warehouse	Buffalo, N. Y.
114		Main steam line failed			R. M. Pooley Mfg. Co.	Saw Mill	Columbus, Miss.
115		Four headers cracked			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
116		Hot water heater exploded			Morris Furniture & Mfg. Co.	Warehouse	Cleveland, Ohio.
117		Water-back of kitchen range exploded			John Novak	Residence	Duluth, Minn.
118		Header cracked	1		Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
119	6	Two sections heating boiler cracked		2	Beckie Diamondstein	Garage	Brooklyn, N. Y.
120		Section of heating boiler cracked			General Motors Corp'n.	Auto Mfg.	Pittsburgh, Pa.
121		Boiler exploded			Brill Battery Station	Battery Station	Blackwell, Okla.
122		Boiler of locomotive exploded			Rock Island Railroad	Railroad	Mineola, Kans.
123		Tube ruptured		2	Harbinson-Walker Refractories		East Chicago, Ind.
124	7	Section of heating boiler cracked		3	B. Rosenberg	Stores & Apartm'ts	Detroit, Mich.
125		Section of heating boiler cracked			St. Colmans Church	Sisters' Home	Cleveland, Ohio.
126		Hot water heater exploded			West End County Club	Club House	New Orleans, La.
127	8	Five sections heating boiler cracked			Jennie I. Gray	Apartment House	San Francisco, Cal.
128	9	Boiler bulged and ruptured			Owosso Gas Light Co.	Gas Plant	Owosso, Mich.
129		Tube failed			Northwestern Bell Tel. Co.	Tel. & Tel.	Duluth, Minn.
130		Section of heating boiler cracked			Sisters of Mercy	Nurses Home	Baltimore, Md.
131	10	Tube ruptured			American Hoist & Derrick Co.	Hoist & Der'k Plt.	St. Paul, Minn,
132	11	Throttle valve ruptured			R. J. Darnell, Inc.	Lumber Mill	Darnell, La.
133	12	Section of heating boiler cracked			F. W. Lumsden	Garage	Storm Lake, Ia.
134		Section of heating boiler cracked			Fanny Rosenthal	Mercantile	Boston, Mass.
135		Three sections of heating boiler cracked			J. S. Silver & E. Aishberg	Offices & Apts.	Hartford, Conn.
136		Three sections of heating boilers cracked			Monarch Company	Mercantile & Mfg.	Stamford, Conn.
137		Seven sections heating boiler cracked			Schwarz, Clifford & Scott	Automobile	Louisville, Ky.
138	12	Water storage tank exploded		1	McLean Ranch	Pumphouse	Avon, Wash.

MONTH OF FEBRUARY, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
139		Boiler exploded		2	Quaker Mfg. Co.		Chicago Hgts, Ill.
140	13	Section of heating boiler cracked			Whitehouse Company	Apartment House	New York City.
141		Section of heating boiler cracked			Grand School	School	Duluth, Minn.
142		Two sections heating boiler cracked			Mass. Institute of Technology	College	Boston, Mass.
143		Two sections heating boiler cracked			Sisters of St. Joseph	Hospital	Dodge City, Kans.
144	14	Section of heating boiler cracked			Board of Education	School	Ft. Recovery, O.
145		Mud drum cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
146		Section of heating boiler cracked			St. Mary's Congregation School	School	St. Mary's, Pa.
147		Hot water heater exploded			Wm. Branyas	Barber Shop	Philadelphia, Pa.
148	15	Section heating boiler cracked			Richard H. Dietz	Business Block	Springfield, Mass.
149		Tube ruptured			Hadfield-Penfield Steel Co.	Clay W'k'g Mchy.	Willoughby, O.
150		Two sections heating boiler cracked			Philjean Realty Co.	Loft Bldg.	New York City.
151		Two sections heating boiler cracked			Warsaw Bakery	Bakery	Hamtramck, Mich.
152		Hot water heater exploded				Tenement	Brooklyn, N. Y.
153		Accident to heating boiler			Adair Street School	School	Valdosta, Georgia.
154		Boiler exploded		1	Miami High School	School	Miami, Okla.
155	16	Section of heating boiler cracked			Borg & Beck Co.	Machine Mfg.	Moline, Ill.
156		Twelve sections heating boiler cracked			Edwin J. Schoettle Co.	Paper Box. Mfg.	Philadelphia, Pa.
157		Tube ruptured			City of Yale	Water, Lt. & Pr.	Yale, Ohio.
158	17	Fittings on main steam line ruptured			Gothenburg Elec. Lt. & Power Co.	Power Plant	Gothenburg, Nebr.
159		Section of heating boiler cracked			Mutual Realty Co.		Atlanta, Ga.
160		Three sections heating boiler cracked			Trustees Masonic Temple	Masonic Bldg.	Braintree, Mass.
161		Hot water heater exploded			Ludwix Chsanwsky	Garage	Philadelphia, Pa.
162		Water back of kitchen range exploded			C. W. Shannon	Residence	Berwick, Pa.
163	18	Accident to heating boiler			Campbell Dairy Co.	Dairy	Kansas City, Mo.
164		Two sections heating boiler cracked			Springfield Country Club	Country Club	Springfield, Mo.
165		Heating boiler exploded		1	Bernard Price	Dwelling	Mattapan, Mass.
166		Hot water heater exploded			D. F. Farnham	Residence	Lynn, Mass.
167	19	Section of heating boiler cracked			Trustees Buckner School Dist.	School	Buckner, Ill.
168		Accident to boiler			State of Connecticut	Hospital & Sanit'm	Newington, Conn.
169		Section of heating boiler cracked			William Intner & Co.	Mattress Factory	New York City.
170		Boiler exploded			New 4th Street Bridge	Construction Work	Algoma, Wis.
171	20	Section of heating boiler cracked			Goodman, Armor & Goodman	Dry gds. & notions	Philadelphia, Pa.

172		Boiler bulged			Schuler Chocolate Factory	Chocolate Factory	Winona, Minn.
173		Header cracked			Waring Hat Mfg. Co.	Hat Factory	Yonkers, N. Y.
174		Boiler exploded		2	Ascher Supply Co.		Columbus, O.
175	21	Economizer tube failed			Pittsburgh Plate Glass Co.	Chemical Works	Barberton, Ohio.
176		Section of heating boiler cracked			East Street Garage	Garage	Chicopee Falls, Mass.
177		Boiler bulged and ruptured			Ball-Sims Lumber Co.	Saw Mill	Pine Hill, Ala.
178	22	Boiler exploded			Amuzer Theatre	Theatre	Lenoir City, Tenn.
179	23	Section of heating boiler cracked			Charles P. Case	Store	Hartford, Conn.
180		Section of heating boiler cracked			Mississippi Drug Co.	Drug Store	Laurel, Miss.
181		Section of heating boiler cracked			Arthur F. Clark	Apartment House	Boston, Mass.
182		Section of heating boiler cracked			Englander Spring Bed Co.	Bed Mfg.	Brooklyn, N. Y.
183		Three sections heating boiler cracked			Peters & Bradley Mill Co.	Flour & Corn Mill	Knoxville, Tenn.
184		Section of heating boiler cracked			City of Utica	School	Utica, N. Y.
185	24	Locomotive boiler exploded	3		St. L.-San Francisco Rwy.	R. R.	Glen Allen, Ala.
186		Heating boiler exploded			Amos Landon	Residence	Cameron, Ill.
187	25	Header cracked			Federal Sugar Refining Co.	Sugar Refining	Yonkers, N. Y.
188		Mud drum of heating boiler cracked			Franklin Printing & Engraving Co	Ptg. & Engraving	Toledo, Ohio.
189		Six headers cracked			Grasselli Chemical Co.	Chemical Works	Tremley Pt., N. J.
190		Hot water heater exploded			California Restaurant	Restaurant	Bay Point, Cal.
191	26	Section of heating boiler cracked			W. G. Nagle Elec. Co.	Electric Supplies	Toledo, O.
192		Four sections heating boiler cracked			Ransey Realty Co.	Apartment House	New York City.
193	27	Four sections heating boiler cracked			Samuel J. Lank	Apartment House	San Francisco, Cal.
194		Boiler ruptured			Southern Pine Products Co.	Pine Prod. Dis.	Hattiesburg, Miss.
195		Hot water heater cracked			Edward S. Towne	Residence	Holyoke, Mass.
196	28	Section of heating boiler cracked			Consolidated Amusement Enterprise	Theatre	New York City
197		Blow-off pipe failed		1	West Side Laundry	Laundry	New York City

MONTH OF MARCH, 1923.

198	1	Tank exploded	1	1	Earl C. Maxwell Co.	Blr. & Tank Wks.	New York City
199	2	Tube ruptured			Wm. H. Manger	Meat Packer	Baltimore, Md.
200		Two sections heating boiler cracked			St. Mary's Church	Church	Clyde, Ohio.
201		Hot water heater exploded			R. Chrystal & Son	Apartment	New York City
202	4	Header cracked			Monsanto Chemical Company	Chemical Works	St. Louis, Mo.
203	5	Tube ruptured			Ideal Laundry Company	Laundry	Dallas, Texas.
204	6	Five sections heating boiler cracked			Mayer & Schneider	Theatre	New York City

MONTH OF MARCH, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
205		Boiler ruptured			Ohio River Sand Company	Sand and gravel	Louisville, Ky.
206	7	Three sections heating boiler cracked			H. B. Means	Hotel	Saguache, Colo.
207	8	Section heating boiler cracked			Englander Spring Bed Co.	Bed Mfg.	Brooklyn, N. Y.
208	9	Three sections heating boiler cracked			Board of Education	School	Jersey City, N. J.
209	10	Header and crossbox cracked			La Favorite Rubber Mfg. Co.	Rubber Goods	Hawthorne, N. J.
210		Six tubes pulled out of drum			Bethlehem Steel Corp	Tin Plate Mill	Sparrows Pt., Md.
211		Tube ruptured			Alex Smith & Sons Carpet Co.	Carpet Mills	Yonkers, N. Y.
212		Boiler of locomotive exploded		1	R. F. & P. R. R. Co.	Railroad	Milford, Va.
213	12	Valve burst			Lee Electric Company	Light & Ice Plant	Clarinda, Ia.
214		Tube pulled out of drum			Standard Tire Company	Rubber	Willoughby, Ohio.
215		Boiler exploded	1		Wallitner Shingle Mill	Shingle Mill	Joyce, Wash.
216	13	Section of heating boiler cracked			City of Utica	School	Utica, N. Y.
217	15	Three sections heating boiler cracked			University Club Bldg. Assn.	Club	Columbia, Mo.
218		Section of heating boiler cracked			H. E. Bidwell	Garage	E. Hartford, Ct.
219		Section of heating boiler cracked			Abraham Cheiffetz	Theatre	Springfield, Mass
220		Five sections heating boiler cracked			R. C. Taylor Estate	Office Building	Worcester, Mass.
221		Section of heating boiler cracked			H. L. Lavietes	Theatre & Mercantile	New Haven, Conn.
222		Section hot water heater failed			D. E. H. Realty Co. Inc.	Miscellaneous	New York City.
223		Two sections heating boiler cracked			Henry Bosch Co., Inc.	Paints & wall ppr.	Chicago, Ill.
224		Boiler exploded		4	Handall Bros.	Saw Mill	Kemper Cty., Miss.
225	16	Tube ruptured			Perry & Co.	Office Bldg.	Philadelphia, Pa.
226		Tube ruptured			City of Owensboro	Elec. Light Plant	Owensboro, Ky.
227		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
228		Section of heating boiler cracked			34 W. 32nd St. Corp'n	Loft Bldg.	New York City
229		Boilers exploded		3	Kuntz Farms	Saw Mill	Cooperstown, Pa.
230	17	Boiler bulged and ruptured			Ohio Hydrate & Supply Co.	Lime Plant	Woodville, Ohio
231		Tubes ruptured	4		French trawler "Vanderwalls"	Fishing Vessel	Off Grand Banks
232	18	Section of heating boiler cracked			Julesburg Heating Co.	Heating Plant	Julesburg, Colo.
233		Hot water heater exploded			C. S. Fassett	Novelties	Caldwell, Kan.
234	19	Tube ruptured and headers cracked			Consolidated Safety Pin Co.	Metal & Wire	Bloomfield, N. J.
235		Section heating boiler cracked			55-57 East 76th St., Inc.	Apartment House	New York City.
236		Boiler bulged and ruptured			Kentucky Silica Co.	Sand	Tiptop, Ky.

237		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
238		Boiler exploded		1		Brass Factory	Mansfield, O.
239	20	Three sections heating boiler cracked			Lord & Downs	Garage	Philadelphia, Pa.
240	21	Section of heating boiler cracked			Household Fibre Prod. Corp.	Fibre Utensils	Winfield, L.I., N.Y.
241		Three sections heating boiler cracked			Revere Beach Co.	Ball Room	Revere, Mass.
242		Hot water heater exploded			Mrs. I. M. Townley	Residence	Mt. Vernon, N. Y.
243	23	Two sections heating boiler cracked			James R. Dee Real Estate Co.	Heating Plant	Houghton, Mich.
244		Three sections heating boiler cracked			Florence G. McKeever	Loft Bldg.	New York City.
245		Five sections heating boiler cracked			Transfer Realty Company	Garage and Stge.	New York City
246		Boiler exploded		2	Cloverdale Dairy	Ice Cream Factory	Hutchinson, Kans.
247	24	Manifold of heating boiler cracked			Cadillac Garage	Garage	Pittsfield, Mass.
248		Boiler exploded	2		Invincible Oil Corp.	Oil Well	Smackover, Ark.
249	25	Boiler exploded			Meridian Creamery Company	Creamery	Meridian, Miss.
250		Section of heating boiler cracked			Board of Education	School	Alpena, Mich.
251		Section of heating boiler cracked			Sonken-Galambia Corp.		Kansas City, Mo.
252	26	Two headers failed			Valley City Milling Co.	Mill	Grand Rpds., Mich.
253	28	Six headers cracked and tubes pulled out			National Tube Company	Blast Furnace	McKeesport, Pa.
254		Section of heating boiler cracked			Danville Bldg. Assn.	College Hall	Champaign, Ill.
255		Boiler ruptured			Nagle Electric Company	Electrical Supplies	Toledo, Ohio.
256		Section of heating boiler cracked			Colonial Courts	Apts. & Stores	Bridgeport, Conn
257		Four sections heating boiler cracked			David J. Ut	Apts. & Stores	New York City.
258		Heating boiler exploded			University of Tennessee	College	Nashville, Tenn.
259		Steam pipe failed		1	Memphis Steel & Iron Works		Memphis, Tenn.
260	29	Boiler exploded		2	Balkwill & Patch	Furniture Factory	Chicago, Ill.
261		Section of heating boiler cracked			Edward R. Clark	Garage	Springfield, Mass.
262		Water leg cracked			Paul Brown Investment Co.	Mercantile Bldg.	St. Louis, Mo.
263		Two sections heating boiler cracked			Independent Tank Line Inc.		Mishawaka, Ind.
264		Boiler ruptured				Construction work	Etna Mills, Cal.
265		Hot water heater exploded			Juan Mello	Barber Shop	Fall River, Mass.
266	30	Locomotive boiler exploded	2	1	Lehigh Valley R. R. Co.	Railroad	Leroy, N. Y.
267		Boiler exploded		2	McKinley Land & Lumber Co.	Lumber Mill	Breece, N. M.
268	31	Tube ruptured	1	2	Owosso Mfg. Co.		Owosso, Mich.
269		Section of heating boiler cracked			Andrea Romano	Bank & Pub. Bldg.	Springfield, Mass.
270		Flange in main steam line ruptured			Village of Harbor Springs	Elec. Light Plant	Harbor Springs, Mich.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1923

Capital Stock, . . . $2,000,000.00

ASSETS

Cash in offices and banks	$532,313.26
Real Estate	255,000.00
Mortgage and collateral loans	1,797,550.00
Bonds and stocks	7,170,021.35
Premiums in course of collection	886,034.35
Interest Accrued	125,956.83
Total assets	$10,766,875.79

LIABILITIES

Reserve for unearned premiums		$4,979,417.54
Reserve for losses		311,286.82
Reserve for taxes and other contingencies		423,444.37
Capital stock	$2,000,000.00	
Surplus over all liabilities	3,052,727.06	
Surplus to Policyholders		**$5,052,727.06**
Total liabilities		$10,766,875.79

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. HART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Trustees, United States Security Trust Co., Hartford, Conn.

LUCIUS F. ROBINSON, Attorney, Hartford, Conn.

JOHN O. ENDERS, President, United States Security Trust Co., Hartford, Conn.

MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.

CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.

HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.

D. NEWTON BARNEY, Treasurer, The Hartford Electric Light Co., Hartford, Conn.

DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.

JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.

EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.

MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.

CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and InsuranceCo.

WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.

SAMUEL M. STONE, President, Colts Patent Fire Arms Mfg. Co., Hartford, Conn.

SAMUEL FERGUSON, Vice-President The Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866. THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, GA.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abel Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	
BRIDGEPORT, CT.,	W. G. Lineburgh & Son, General Agents.
404-405 City Savings Bank Bldg.	A. E. Bonnnet, Chief Inspector.
CHICAGO, Ill.,	J. F. Criswell, Manager.
209 West Jackson B'v'l'd	P. M. Murray, Ass't Manager.
	J. P. Morrison, Chief Inspector.
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio,	W. E. Gleason, Manager.
First National Bank Bldg.	Walter Gerner, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chesnutt,
916-918 Gas & Electric Bldg.	Manager and Chief Inspector.
HARTFORD, Conn.,	F. H. Kenyon, General Agent.
56 Prospect St.	A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector
Hibernia Bank Bldg.	E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y.	C. C. Gardiner, Manager.
80 Maiden Lane	E. Mason Parry, Chief Inspector.
	R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	Wm. J. Farran, Consulting Engineer.
	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	McCargar, Bates & Lively, Gen'l Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
301 Thomas Bldg.	
SAN FRANCISCO, Cal.,	H. R. Mann & Co., General Agents.
339-341 Sansome St.	J. B. Warner, Chief Inspector.
ST. LOUIS, Mo.,	C. D. Ashcroft, Manager.
319 North Fourth St.	Eugene Webb, Chief Inspector.
TORONTO, Canada,	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.
Federal Bldg.	

CARNEGIE LIBRARY
1924

THE HARTFORD LINE

BOILER INSURANCE

Boilers, Economizers, Vulcanizers, Kiers, Digesters, Steam Driers, Jacketed Kettles, Etc.

FLYWHEEL INSURANCE

Flywheels, Fans, Blowers, Turbines, Water Wheels, Centrifugal Driers, Gear Wheels, Etc.

ENGINE INSURANCE

Engines, Compressors, Pumps, Refrigerating Machines, Etc.

ELECTRICAL MACHINERY INSURANCE

Generators, Motors, Synchronous Convertors, Transformers, Switchboards, Etc.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER
INSPECTION and INSURANCE CO.
HARTFORD CONNECTICUT

"The *oldest* in the Country, the *largest* in the world"

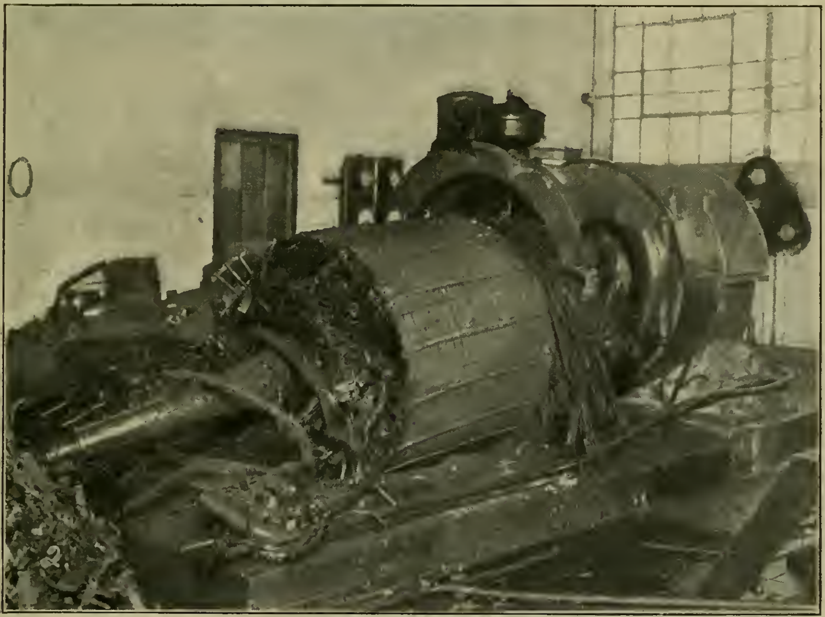
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXV HARTFORD, CONN., APRIL, 1924. No. 2.

COPYRIGHT, 1924, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



TURBO-GENERATOR ACCIDENT AT CEDAR RAPIDS, IOWA.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Failure of a 2,000 K. W. Turbo-Generator.

A SERIOUS accident occurred at the plant of Penick & Ford, Ltd., at Cedar Rapids, Iowa, February 15, 1924, when a 2,000 k.w. turbo-generator ran away. The entire unit was wrecked and, including damage to the building and to other apparatus, the total property loss amounted to $35,000, which was covered by a Hartford policy.

The direct cause of the accident is not clear, but the evidence indicates that in some way the machine lost its electrical load. An examination of the wrecked generator failed to show any signs of burning or other electrical disturbance, it apparently being electrically dead before disruption occurred. Evidence of overspeed, however was apparent and indicated that, when the turbine lost its load, both the governor and emergency stop failed to function quickly enough and the machine "ran away," although a recent inspection had indicated that these valves were functioning properly.

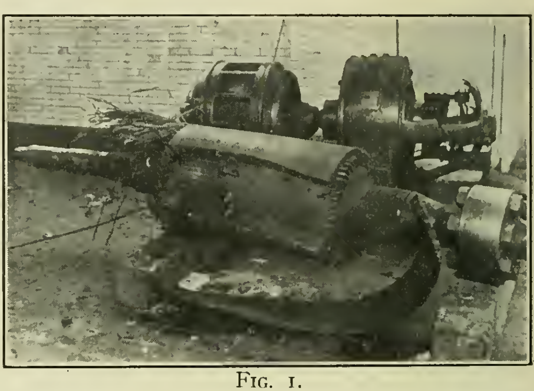


FIG. 1.

The accompanying pictures show very plainly some of the unusual features of this accident. The cover page illustration is a view of the generator end of the machine and gives an idea of the completeness of the wreck. The rotor disrupted, gripped the stator windings and caused them to turn with it to a certain extent, thereby rupturing the entire generator frame. The rotor can be seen firmly wedged within the stator

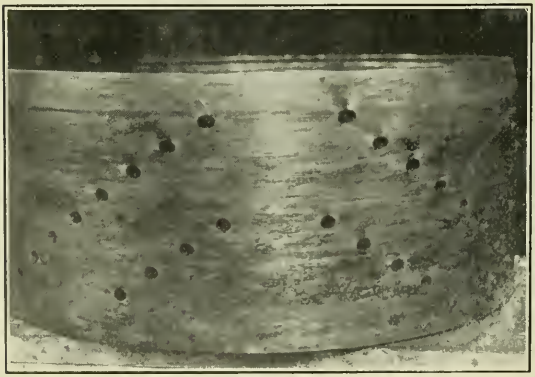


FIG. 2.

windings. Figure 1 is a view of the rotor after it had been removed from the wreckage. It will be observed that torsional force has wrenched the shaft so that the slots are no longer parallel to the axis, and that centrifugal force has torn away a large section of the laminated discs of which the outer part of the rotor was composed. In the background of this picture can be seen the ruptured frame of another machine.

Figure 2 is a view of an end shield of the field winding, and is of interest as giving evidence of excessive overspeed. This ring is 1½″ thick and is drilled in diagonal rows of ½″ holes for ventilating purposes. As can be seen in the picture, these holes are considerably elongated circumferencially as a result of the hoop tension developed. The other end shield, shown in the foreground of Figure 1, disrupted through a line of holes and flattened out.

The turbine itself did not explode, but the shaft was bent, the blades being seriously damaged by rubbing against the stationary parts. The discs also had sheared their keys and rotated slightly on the shaft.

Safety Valves.

THEIR APPLICATION TO PRESSURE VESSELS OTHER THAN BOILERS.

By J. A. Snyder, C. I., Pittsburgh Dept.,
and
Wm. D. Halsey, Editor, The Locomotive.

WE have previously discussed, in the October 1923 and the January 1924 issues, the question of *Safety Valves,* both from the standpoint of maintenance and the method of operation of such valves. The previous articles have been devoted primarily to the steam boiler field, but there are other classes of pressure vessels that find use for a safety valve, and it is this use that we now desire to give some consideration.

In the larger power plants of today there is considerable use of superheated steam. While a steam superheater normally contains a relatively small amount of energy and usually has a free connection to a boiler which is equipped with safety valves, yet there is a very definite use and place for such a valve on a superheater. The purpose of such a valve is not so much to prevent overpressure as it is to protect the superheater from burning out. If the safety valves on the boiler are of sufficient capacity to give protection against overpressure it is not necessary to equip the superheater with valves of capacity sufficient to relieve all the steam that the boiler can generate, but it is essential that a continuous flow of steam be provided for. As stated above, the chief purpose of a safety valve on a superheater is to protect the vessel against burning out, and to do this a moderate sized valve is installed on the outlet end of the superheater. This valve is set to relieve at a few pounds less than the main valves on the boiler so that, if for any reason the demand for steam suddenly ceases, this superheater safety valve will release first and a flow of steam will be kept up through the superheater tubes thereby preventing their over-heating.

Safety valves on superheaters necessarily handle high temperature steam so that they should be of the outside spring type and their working parts should be especially designed for the purpose.

When there are no intervening valves between the superheater safety valves and the boiler, the safety valves on the superheater may be considered a part of the required safety valve equipment of the boiler provided that the valves on the boiler proper are equal to at least 75% of the required capacity.

Safety valves on economizers should be ample in size and it is well to provide at least two valves. The generally accepted proper location for an economizer safety valve, if only one is used, is at one end of the top longitudinal header. If two or more valves are used, they may be placed at the ends, or the ends and the middle, of the header.

The practice of leading the escape pipes from economizer safety valves to a return tank so that any hot water that may be discharged will be returned to the system is a practice to be deplored as such an arrangement does not enable the operator to see how the valves are functioning, and there is a chance, therefore, of their getting out of repair. It is much better to have the pipes so arranged that any escape of water will be noted by the operator who will then know that the valves are operating properly or are leaking.

Because of the difference in pressure necessary to cause flow of the water from the economizer into the boiler it is necessary to set the safety valves on the economizer to release at a pressure somewhat greater than that on the boiler. However, this difference in setting should be no greater than is actually required.

It should be borne in mind that an economizer is a vessel designed for heating water and not for generating steam. Under certain conditions the flow of water through an economizer may be so small that steam will be generated and, since steam is not anything like the conductor of heat that water is, parts of the economizer may be subjected to unequal expansion with resultant weakening of the joints. Thus an economizer may be ruptured and a violent explosion take place even though the safety valves are properly set and in good operating condition. Temperature control of economizers would appear to be the best solution of this difficulty.

Going outside of the power plant we find a use for safety valves on many vessels used in process work and this use is worthy of a good deal of thought. It is a common thing to find a vessel of this nature operating at a low pressure but being supplied by steam from a relatively high pressure system, use being made of the pressure reducing valve to effect the desired change.

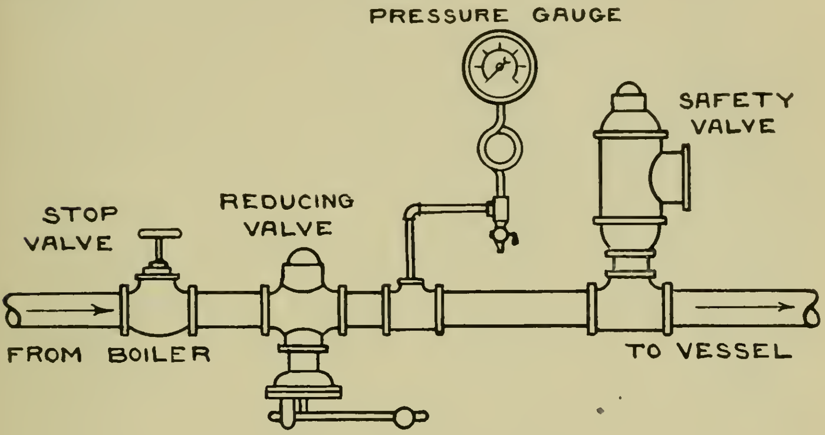
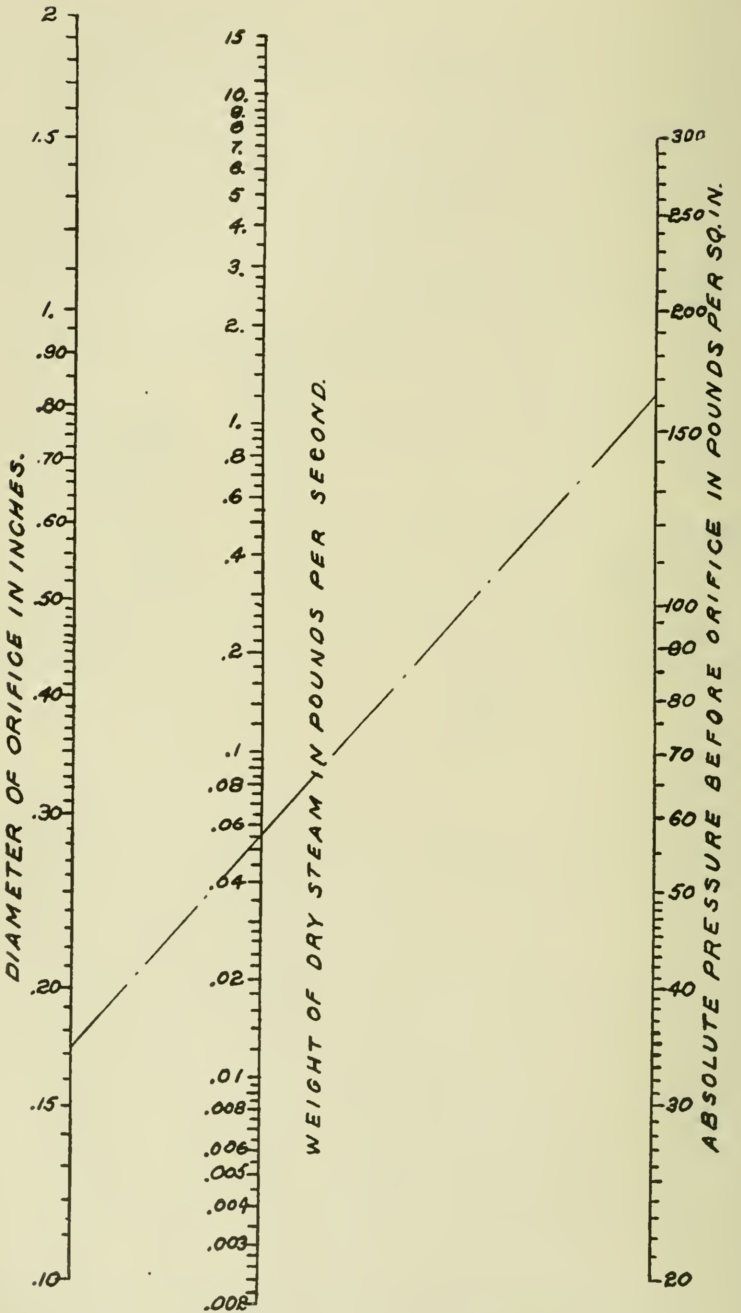


Fig. 1.

It should be borne in mind that although a pressure reducing valve may control the reduction of pressure very nicely as long as there is a fairly good flow of steam, there is great danger of the pressure being equalized on both sides of the valve should there be a very small flow. Although a new valve may close tightly it will be readily appreciated that leakage through the valve may develop which will surely result in a rise of pressure on the low pressure side should this leakage permit a supply of steam greater than is actually required. Furthermore, since any automatic device may become deranged, there is a possibility of the reducing valve ceasing to function with a consequent rise in pressure in the vessel it is supposed to protect and this rise may go as high as the full boiler pressure. In an attempt to protect the vessel against too high a steam pressure the arrangement shown in Fig. 1 has been used, the safety valve being set for a pressure that the vessel can carry with a reasonable factor of safety.

A safety valve so applied will act as a warning signal should there be a rise in pressure and it might, under certain conditions, protect the



GRASHOFF'S FORMULA $W = 0.0165\, A\, P_1^{0.97}$

Adapted from Lipka's "Graphical and Mechanical Computation."

vessel. The dangerous possibilities inherent in such an arrangement will be seen, however, if we suppose that a small vessel requiring only the steam that could be supplied by a 2 h. p. boiler be connected to a steam line from a 500 h. p. installation. For real protection in such a case the safety valve should have sufficient capacity to discharge all the steam that could possibly flow through the supply pipe with the full boiler pressure behind it and with the reducing valve inoperative. If the supply pipe should happen to be large in size it will be readily seen that a rather large safety valve would be necessary to prevent an excessive rise in pressure.

If the demand for steam at a low pressure warrants it, then undoubtedly the safest arrangement is to have a low pressure steam line supplied by a low pressure boiler or battery of boilers. With such an installation the safety valves on the boilers will protect all the vessels. If long steam lines are necessary to reach some vessels, then the boiler pressure should be raised only enough to take care of the pressure drop, the pressure on the vessels being controlled by pressure reducing valves and the vessels themselves being constructed strong enough to safely withstand the full boiler pressure.

Where the proper balance between low pressure steam demands and power demands can be obtained, the use of a " bleeder " or extraction turbine would be a good arrangement. This would give a supply of clean steam at whatever pressure desired and would be reasonably safe since the high pressure stages of the turbine would act as a very positive pressure reducer.

Where there exists a demand for low pressure steam from high pressure supply and no other scheme than that shown in Fig. 1 seems economically possible, there is an arrangement that might be used with a fair degree of success. This scheme would be to insert an orifice or plate with a small hole in it, in the steam line ahead of the reducing valve, the hole to be of such size that it would limit the flow of steam should the reducing valve cease to function. The idea may perhaps be best explained by a concrete example.

Let use suppose that we have a vessel, such as a drying roll, which is operated at 15 lbs. steam pressure and requires approximately 100 lbs. (weight) of steam per hour. Let us suppose further that the design of the vessel is such that it can carry 25 lbs. pressure with reasonable safety. The main steam line pressure is 150 lbs. If we have an orifice which under these conditions would pass a maximum of say 200 lbs. (weight) of steam per hour with the reducing valve offering no resistance to the flow it would appear that the supply of steam would be adequate under all conditions. A system like this would be protected by a safety valve with a discharge capacity of something more than 200 lbs. per hour at 25 lbs. pressure.

The size of the orifice to attain the above result may be obtained from the chart on page 38. This chart is based on the formula:

$$W = \frac{AP^{.97}}{60}$$

where **W** is the flow of steam in pounds per second, **A** is the area of the opening in square inches and **P** is the absolute pressure of the steam (gauge pressure + 15 pounds, approximately).

To use the chart, find the point on the pressure scale for the initial or steam main pressure (absolute) and the point on the weight scale for the desired flow. Through these two points draw a straight line and the point where this line intersects the "diameter of opening" scale will indicate how large an orifice should be used.

This scale, or "nomographic chart" as it is called, has certain limitations as regards our particular problem. In the first place it is not to be used if the working pressure at which the safety valve on the vessel is set is greater than 58% of the steam main pressure. Secondly, it indicates the steam flow to be expected from a diverging nozzle such as is used in a steam turbine. The actual flow through a plain hole in a thin plate would be less than that shown. In the average case it would be about 80% of the amount shown on the chart.

The solution of the present problem is shown by the diagonal line on the chart and it appears that an orifice .172″ in diameter would be proper. This orifice would probably actually pass only 160 lbs. of steam per hour and since a 1″ bevel seat safety valve with a "high lift" has a discharge capacity of 218 lbs. per hour (See tables in *A. S. M. E. Boiler Code*) such a valve would be the proper size to use. A 1¼″ valve with a medium lift would also serve. We might use a 1″ medium lift which has a capacity of 174 lbs. but since the efficiency of the orifice is somewhat of a conjecture it would be best to consider that the orifice might discharge the full amount indicated by the chart.

This arrangement, it will be seen, provides an orifice that cannot pass more than 200 lbs. of steam per hour with a main steam line pressure of 150 lbs. gauge. This we have assumed to be ample to supply the vessel which it heats, the actual flow, which would be less than 200 lbs. per hour, being controlled by the reducing valve. However, should the reducing valve fail to function and permit a full flow of steam through it, then not more than 200 lbs. of steam per hour would flow and if the pressure did build up in the vessel to 25 lbs. the safety valve would open and prevent a further rise since the valve we have chosen could, if necessary, discharge all the steam that the orifice could supply.

The use of an orifice for limiting the flow of steam is not a new idea. Forced draft fan engines which are controlled by automatic steam flow devices actuated by the steam pressure are often protected from runaway, should the automatic device fail, by the insertion of an orifice in the steam supply line. The same scheme would appear applicable to the limiting of the steam flow to pressure vessels.

Air Compressor Lubrication.

Its Relation to Explosions in Compressed Air Systems.

By B. C. Cruickshanks, Ass't Editor.

THE lubrication of air compressors is a problem which has given many engineers much cause for thought, primarily because of the really difficult nature of the problem, but supplemented by the lack of real information on the subject and the inaccessibility of such information as existed. The generally unsatisfactory results obtained, coupled with the many explosions which have occurred in high pressure lines and which have been laid at the door of the lubricating oil used, led to many investigations and discussions of the subject with gratifying results. It is the purpose of this article to point out some of the difficulties frequently met and to recommend, as far as possible, means for overcoming them.

Air compressors are of many and varied types, but in general can be classified into three main divisions, namely, fans or blowers, including all centrifugal machines, rotary compressors, and piston type compressors. Each has its own particular field.

The fan or blower is used primarily where large volumes of air are desired at very low pressures, as for instance, in heating and ventilating systems. The fan may be either of the propeller type depending on its speed and the pitch of the blades to impart the required velocity to the air, or it may be of the centrifugal type depending on the centrifugal force developed. Pressures in these types are usually below one pound.

Turbo compressors might be included in this class except for the fact that they are designed for the purpose of attaining higher pressures. Sometimes termed centrifugal compressors, they operate upon exactly the same principle as the multistage centrifugal pump. A series of impellers is arranged so that each one discharges into the intake of the succeeding one via an intercooler, an increase in pressure of from two to four pounds being obtained for each stage. The turbo-compressor is built for pressures up to 100 pounds and sometimes more.

The rotary compressor depends upon an entirely different principle. In this type a certain amount of air at intake pressure is entrapped by the rotating elements, and in moving through the machine toward the discharge, the volume is decreased thereby increasing the pressure. Various designs are found in this class, but as the compression ratio is limited and large volumes of air are not so easily handled as with the fan type, their application is more of a special rather than a general nature. The usual operating pressures are between one and five pounds with ten pounds as a probable maximum.

None of the above types offers any new problems in lubrication. The moving parts do not make contact with each other nor with the casing, journal friction alone having to be cared for.

The piston type or reciprocating compressors may in turn be divided into three classes — blowing engines, and single and multistage compressors. Blowing engines run at comparatively slow speeds and are used primarily by steel plants in connection with blast furnaces and Bessemer converters for the positive handling of large quantities of air at pressures which rarely exceed fifteen or twenty pounds. The single stage piston compressor handles smaller volumes of air but at higher pressures, the multistage compressor being almost universally used in the field above 150 pounds.

In discussing the lubrication of the piston type air compressor it might be of assistance to compare it with the ordinary reciprocating steam engine. In general layout they are practically identical. However, instead of the air in the cylinder operating the engine, the engine is run by some outside source and does work upon the air entrapped in the cylinder. In a steam engine a small quantity of high pressure steam enters the cylinder, expands to a greater volume, and is exhausted at a lower pressure and temperature, the drop in pressure and temperature being a result of the work done on the engine by the steam. In a compressor a large quantity of low pressure air is drawn into the cylinder, compressed to smaller volume, and discharged at a higher pressure and temperature, the increase in pressure and temperature representing the work done on the air by the machine. With such a similarity between the two it would be natural to look for some similarity in the methods of lubrication, and such is found to be the case. As stated above in connection with the other types of compressors, the lubrication of bearings, cross-heads and crank-pins offers no particular difficulty and will not be considered further at this time.

The lubrication of the cylinders of single acting machines having trunk pistons is frequently accomplished by the splash system. In this method a certain oil level is maintained in the crank case and, as the crank revolves, it dips into this oil splashing a quantity into the open end of the cylinder. The amount of lubrication is here governed by the height of oil in the crank case. In double acting compressors the oil for cylinder lubrication is either introduced into the intake pipe just ahead of the valve or else is fed directly into the cylinder. When fed into the intake pipe, the incoming air atomizes the oil and consequently deposits a certain amount upon everything with which it comes in contact.

Difficulty is experienced with air cylinder lubricating oil because of the severe conditions with which it must cope. An oil good at the ordinary temperatures will thin out and lose its viscosity at the higher temperatures. Increased volatilization of the oil is also brought about under such conditions with an apparent increase in the explosion hazard. Furthermore, with abnormally high temperatures, it has been felt that the flash point of the oil probably had been reached. The remedy appeared to be heavier or more viscous oils with correspondingly high flash points, and such was the general trend in compressor lubrication. Heavier oils, however, do not so readily lend themselves for distribution over the desired surfaces, and consequently require that a greater quantity be supplied in order to insure complete lubrication. Nor does their use overcome the objection regarding volatilization, for instead there is set up a "cracking" process or fractional distillation, lighter oils being vaporized and leaving behind a heavy residue. This gummy residue collects everywhere and, as it is of a carbonaceous nature, composed largely of fine carbon and robbed of its own lubricating properties, it acts to prevent the effective use of any lubricant. This is especially noticeable in its effect on the valves, interfering with their proper operation to a dangerous degree, as we shall note later. Aside from this destruction of the lubricating properties of the oil, it would also appear that the increased amount of carbon deposited in the system brings about an increased explosion hazard. Of this we will say more later.

A good compressor oil should be just heavy enough to retain sufficient viscosity at operating temperatures to properly lubricate the walls of the cylinder and to seal the piston, although the flash point should not be too low. Conditions will vary somewhat with different machines, and buying on specification is not entirely satisfactory. Quoting from "*Trade Standards*" of the Compressed Air Society,— "The importance of good air cylinder oil is now recognized by all the leading manufacturers of lubricants, and all of the reputable oil companies today put out an oil which they recommend for air cylinder service, so our recommendation is to use only the best grade of air cylinder oil as sold by any of the reputable oil companies."

The use of the proper oil is only the first step toward satisfactory operation. Regulation of the amount of oil fed, control of temperature, and periodic cleansing of the system are factors which must receive due attention. The oil may be fed into the intake pipe where it is atomized and carried into the cylinder by the air, or it may be fed directly into the cylinder, and there is apparently little to choose between the two methods. Force feed should be used as it will insure a proper supply of oil, especially when the lubricator is positively driven. The supply will then be a certain definite quantity per cycle regardless of the speed, and an overabundant supply of oil can be prevented. Excess oil is fundamentally regarded as a fertile source of the carbonaceous deposits.

Consideration of temperature control and care of the air system brings us to the subject of explosions in this type of apparatus. The cause and prevention of such explosions has been a matter of much speculation, but it has long been recognized that the great majority are due to combustion and not overpressure. Rapidly successive rather than simultaneous explosions in the same system, flashes of fire at the time of an explosion, and the appearance of the wreckage after the accident, all serve to confirm this theory. The lubricating oil being the only substance other than the air and its impurities introduced into the system, it was not difficult to locate the source of the explosive, but its exact nature is still somewhat of a question. Some have felt that the flash point of the oil itself had been reached due to some irregularity in operation of the compressors. Others have maintained that fractional distillation has been responsible for the formation of explosive vapors, while still others hold to the theory of the formation of carbon monoxide and other combustible gases. However, as pointed out in a paper presented before the South African Institution of Engineers by Mr. J. A. Vaughn, a comparison of the amount of oil to the amount of air will show that the formation of an explosive mixture with oil vapor is practically impossible even though all of the oil were volatilized. "The amount of oil used for internal lubrication of the air ends of compressors appears to be about one pint to two (or three) million cubic feet of free air, say, one of oil to 150,000 (or 225,000) parts of air by weight." Computations based on recommended practice as given in the table on page 47 show wider limits than these, the ratio of oil to free air ranging from one part in 60,000 to one part in over 300,000. As far as we are able to learn, the greatest dilution of an inflammable substance by air which will produce an explosive mixture is approximately one to forty parts by weight.

Seeking elsewhere for the source of an explosive, analyses of the "carbon" deposits in compressors and air lines have shown them to be composed of fixed carbon, volatile matter, and ash. Quoting again from the same paper, "The writer has not at his disposal the ultimate analysis of any of these deposits, so that he must rely on approximations in order to assess their possibilities with respect to explosions. Suppose a deposit to consist of: Fixed carbon, 30 per cent.; volatile, 56 per cent.; ash, etc., 14 per cent. Neglecting the effect of any moisture, one pound of this substance will yield gases (principally hydrocarbon and hydrogen) to the extent of $\frac{56}{100} \times 25 = 14$ cubic feet, assuming the gaseous mixture to be slightly heavier than coal gas. [The author assumes 25 cubic feet as the volume occupied by one pound of the gaseous mixture which the deposit might yield.]

"In addition, if the carbon content burns to CO [carbon monoxide], 9 cubic feet (approximately) of this gas will be formed.

"The lower limit of explosibility for this combination of gases may be about 8 per cent., in which case over 280 cubic feet of explosive mixture might be formed from 1 lb. of deposit, under exceptionally favorable conditions. . . . ."

"If the deposit is oxidisable under ordinary circumstances, constant exposure to heated compressed air must accelerate the oxidation, and in some portion of this mass (as with the coal dust) local ignition must take place. Then follows destructive distillation, mixture with air, the formation of explosive mixture and ignition of same by the burning material."

Whether or not the above theory regarding the means of igniting the explosive mixture is correct is a debatable question. It has been suggested that static electricity may furnish the spark. Static electricity, as we know, is a result of friction, having once been known as "friction electricity." The passage of the air through the valves takes place at high velocities which, at the increased density, must create considerable friction. Whether or not this can gradually " charge up " the compressor until a favorable time to " discharge " occurs is an open question.

Though we cannot say definitely just what causes the actual explosion, we do feel safe in saying that increase in temperature above normal is a contributing factor. The normal temperature can be regulated by proper design. Increase in temperature is proportional to the compression ratio, so that by dividing the work amongst several stages and supplying intercoolers between each stage the temperature can be kept down to a prescribed figure. In order to prevent any abnormal rise, however, it is essential that the valves be kept in proper working condition, for leaky valves invariably result in a higher temperature of the receiver air. The leakage air is at a higher pressure and temperature than that in the cylinder into which it finds its way. Since it is not doing any external work, the resultant drop in temperature after expansion is very small, the cylinder charge being therefore heated above what its normal temperature would be. This goes on stroke by stroke until either a balance is reached, the heat losses preventing a further rise, or else an explosion occurs.

The increase in temperature is more rapid at reduced loads. This is due primarily to the fact that less air is passing through the compressor, as a result of which the heat is not carried off and dispelled but builds up the temperature of the more or less stationary air. This rise is further augmented by increased leakage due, in the case of speed governed compressors, to the slower speed, and in the case of constant speed machines, which are governed by throttling the air supply, to an increased difference in pressure between the intake and discharge.

Having examined into the causes of explosions in air compressors and compressed air systems, we should be able to take steps looking toward their prevention. Since the carbonaceous deposits are the main seat of trouble, then the prevention of such deposits is of prime importance. First look to the lubricating oil. See that it is a suitable oil and that only just enough and no more of it is used. The proper method of selecting the oil has been previously considered. As to quantity, it should be borne in mind that an air compressor cylinder requires much less oil than does a steam engine cylinder. There is no moist steam present persistently washing it off. The proper amount can most readily be determined by an examination of the cylinder walls and the discharge valve immediately after shutting down. If they show a moist oil film, then enough is being supplied, but if these parts are dry, the oil supply should be increased. The following table, which gives the recommended practice of the Compressed Air Society, may be used as a guide.

TABLE SHOWING APPROXIMATE AMOUNT OF AIR CYLINDER OIL REQUIRED FOR GOOD LUBRICATION

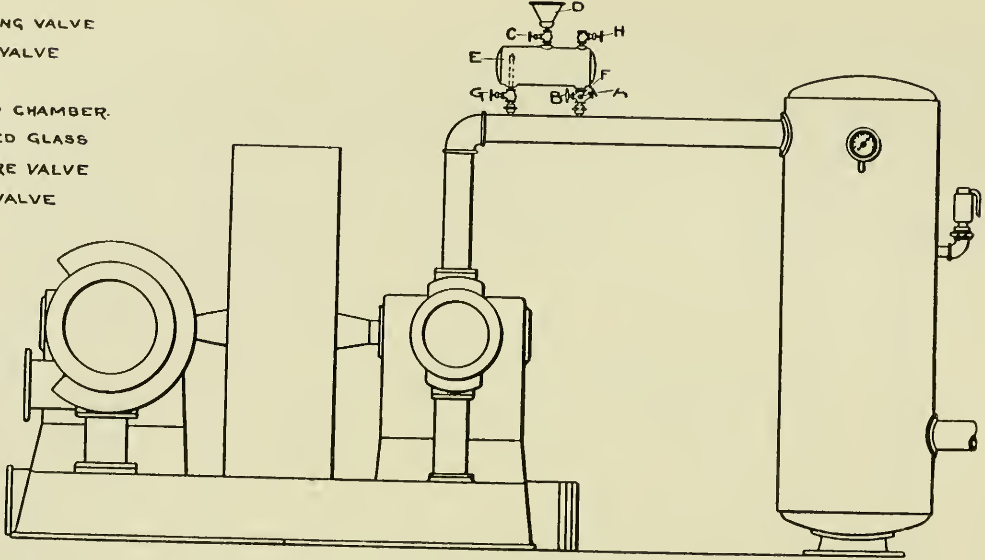
Cylinder Diameter	Piston Displacement	Rubbing Surface Sq. Ft.	Oil Feed Drops per Minute	Oil Feed Pints per 10 Hours
Up to 6″	Up to 65	Up to 500	1	.05
6″ to 8″	65– 125	500– 750	1	.08
8″ to 10″	125– 225	750–1100	1	.11
10″ to 12″	225– 350	1100–1500	1– 2	.14
12″ to 15″	350– 600	1500–2000	2– 3	.20
15″ to 18″	600–1000	2000–2600	3– 4	.27
18″ to 24″	1000–1800	2600–3600	4– 5	.36
24″ to 30″	1800–3000	3600–4800	5– 6	.48
30″ to 36″	3000–4500	4800–6000	6– 8	.60
36″ to 42″	4500–6500	6000–7500	8–10	.74
42″ to 48″	6500–9000	7500–9000	10–12	.90

The above figures are for one cylinder only.
For Duplex or Compound Machines both cylinders must be considered.
Cylinders having Corliss valves should use 50% more oil.

Another precaution against the formation of these dangerous deposits in the system is the guarding of the source of air supply, particularly in certain localities. Many air systems are operated in connection with mine work, especially high pressure systems used in charging locomotives for coal mines. Since carbon forms the basis of most of the objectionable deposits in air systems, it is reasonable to suppose that a considerable portion of it may enter as dust and coal dirt with which the atmosphere is laden in the vicinity of the mines. It is therefore recommended that proper steps be taken to insure that clean air only be drawn into the system. It might be pointed out in this connection that air taken from out of doors will probably be cleaner than air from inside and will most likely be cooler, and can therefore be handled more economically by the compressor.

It is advisable to blow down the system periodically and at regular intervals, using steam if feasible, thus removing all sediment as far

A- SHUT OFF VALVE
B- REGULATING VALVE
C- FILLING VALVE
D- FUNNEL
E- COMPOUND CHAMBER.
F - SIGHT FEED GLASS
G - PRESSURE VALVE
H - RELIEF VALVE



COMPOUND:- MIX 1 LB., OF RED SEAL LYE TO 18 LBS., OF WATER.

TO USE COMPOUND:- CLOSE VALVES "A" AND "G", OPEN VALVES "C" AND "H" AND FILL COMPOUND THROUGH FUNNEL "D", WHEN CHAMBER "E" IS FILLED CLOSE VALVES "C" AND "H", OPEN VALVES "G" AND "A" AND REGULATE FEED BY VALVE "B".

DEVICE FOR CLEANING CARBON IN AIR DISCHARGE LINE AND RECEIVER OF AIR COMPRESSOR

FIG. 1.

as possible. The pumping of a soap solution into the compressor through the lubricator is found by many to assist materially in the removal of hard and gummy deposits. The usual solution consists of approximately one-half pound of soft soap per gallon of water, and should be fed about ten times as rapidly as the oil. The frequency and duration of this injection should be governed by the conditions of the system. Under no circumstances should gasoline, kerosene, or other inflammable substance be used.

Another method of cleaning, suggested by the Compressed Air Society, makes use of a lye solution injected into the discharge line by a special apparatus made of 5″ or 6″ pipe, as shown in Figure 1. The solution is fed into the line at the rate of 60 to 70 drops per minute while the compresser is running, and should be used once a month or oftener as conditions require.

The factors tending to abnormally increase the temperature of the air should also receive their due attention. The valves should be cleaned frequently and examined to see that they are in good condition. Frequent and periodic indicating of the compressor will be of assistance in checking the condition of the valves. Intercoolers and after-coolers should be provided and kept in proper operating condition. It is also essential that the cylinder jackets be kept clean and the water circulating. The jacket water not only helps to keep down the temperature of the machine, but also has a very important function in connection with cylinder lubrication. The cool water chills the cylinder walls and causes an increase in the viscosity of any oil that may be upon them. This materially increases the lubricating qualities of the oil and also makes it a more effective seal for the piston. In order to easily detect whether or not the cooling water is circulating, all pipes should have an independent discharge in the open so that each one can be readily seen by the operator. A thermometer placed in the discharge air line near each machine will be of further assistance to the operator in checking up on unusual temperature conditions. Fusible plugs with a fusing point of about 400° Fahrenheit may also be placed in the same approximate location.

A discussion of explosions in air systems would not be complete without some comment on air receivers as they are frequently thought to be the seat of certain explosions. A receiver is placed in the air line to act as a surge tank to steady the pressure as well as the speed of the compressor. For these purposes it is very effective and is a really essential part of a compressed air system. Since such a large proportion of the air is stored here, it is also the logical place for a safety valve. The receiver furthermore acts as a separator of oil, moisture, and other impurities, which settle out because of the decreased velocity through the receiver. On this account it should be fitted with suitable blow-off connections and regularly blown down as a matter of routine. Its danger is thought to lie in the possibility of inflammable gases or vapors collecting therein due to incorrect piping connections. To obviate this possibility it has been recommended that the connection be made near opposite ends, the air entering near the top and discharging somewhat further down.

The Value of Inspection Service. Can It Be Rated in Dollars and Cents?

By Inspector E. H. Vaux, Pittsburgh Department.

THE writer, while making a regular trip of inspection, recently visited the lighting plant of a small town. This power plant consisted of four water tube boilers and three turbo-generators. Two of these generators were of 300 k.w. capacity and the third one of 750 k.w. capacity.

At the time of the visit, one of the 300 k.w. units was being overhauled. The 750 k.w. unit was running apparently in good order and carrying full load, the governor being set to control the speed at 3600 r.p.m. In order to try the emergency stop, the load was taken off, whereupon the governor failed to control the turbine, its speed increasing until the stop tripped at 3750 r.p.m. It was decided that the stop was set a little too close, and it was adjusted. The turbine was started again, and again the governor failed to function, the stop tripping at 3850 r.p.m.

After trying to overcome the difficulty by making minor adjustments to valve gear, the governor still failed to control speed. It was then decided that the valves were leaking and would have to be ground in. However, the machine could not be spared at this time, as the load was too large for one of the smaller turbines. In order to give the town light, the turbine was throttled until we got it back in service, after which it apparently operated correctly. This occurring on Friday, it was decided to look at the valves on Sunday.

When the valves were removed it was found that the valves and seats were in good order, but the steam chest was honeycombed with sand holes through which enough steam leaked to overspeed the turbine when it was running light. The casting was replaced by a new one, after which no further difficulty was experienced.

Do not take for granted that everything is right. Try it and be sure. If this turbine had lost its load, and the emergency stop had failed, there would have been an accident.

Boiler Explosion at Loreauville, Louisiana.

A DOUBLE boiler explosion of extreme violence occurred at the plant of the Loreauville Sugar Company, Loreauville, Louisiana, November 21, 1923, causing a property loss of $47,000. Twelve persons were killed and twenty-three injured. Whole boilers and parts of boilers sailed around in the air and caused widespread damage, some idea of which may be obtained from the accompanying illustration.

Boiler Explosion at Loreauville, La.

The large property loss is due to the expensive type of some of the apparatus damaged, since the buildings contained large cast iron evaporators and other costly machinery.

The cause of a boiler explosion can generally be determined by examining the wrecked boiler and questioning the persons who were in or near the boiler room at the time. In this case, the persons who might have been able to tell what had been done were killed. The boilers were in charge of a thoroughly competent man who had had more than twenty years' experience with such equipment. It is a

(Continued on page 54.)

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, Editor. B. C. CRUICKSHANKS, Assistant Editor.

HARTFORD, APRIL, 1924.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

WE once knew a man who believed in the old adage, "Let well enough alone." This man was also the owner of an automobile which was well out of the "flivver" class. Apparently having the courage of his convictions, he suited the action to the word, and, with the exception of refilling the fuel tank and having the crank case drained now and then, with perhaps an occasional washing, no attention whatever was given to keeping the machine in good running order. The hood was never raised, not even to clean off a spark plug.

Perhaps such a condition of affairs should not be too harshly criticised so long as the only ill effects are felt by the owner's pocketbook. Should there be a reaction upon others, however, particularly should such a condition carry with it danger to life and limb, then criticism would be in order. From our investigations of accidents to compressed air systems, it would appear as though many compressors are operated under conditions at least approaching the above. We are therefore presenting elsewhere in this issue a review of the subject in the hope that it will be of assistance to some in securing better operating conditions and in reducing the hazards attending the operation of compressed air systems.

Obituary.

James F. Criswell.

JAMES F. CRISWELL.

A life of thirty-five years of loyal service to this Company came to an end on March 21, 1924 by the death of James F. Criswell, Manager of the Chicago department.

Mr. Criswell was born at Canal Dover, Ohio, on February 28, 1863, and his early life was spent on a farm. His father lost his life in the Battle of the Wilderness, after which Mr. Criswell went with his mother to live at Sterling, Illinois, where he served an apprenticeship as a machinist. Later he entered the insurance business.

His ability in this field of work was early recognized and he was appointed a Local Agent of The Hartford Steam Boiler Inspection and Insurance Company at Sterling. In May 1889 he entered the employ of the Company as a Special Agent. Upon the death of former

Manager H. M. Lemon of the Chicago department in February 1918, Mr. Criswell was appointed Acting Manager and later in that year was made Manager.

Mr. Criswell was a charter member of the Illinois Athletic Club and a past president of the Ashland Club.

Mr. Criswell's genial nature and true friendship won for him many warm friends in business as well as in social life. For any favor extended to him he was ever grateful, and his constant purpose was to render service to others. His home life was one of great happiness and to his religion he was always devoted. The memory of such a man will always be a treasure.

To Mr. Criswell's wife and daughter, who survive him, his friends extend their warm sympathy.

Personal.

Mr. W. A. Bayliss has been appointed Chief Inspector of the Boston Department of this Company to fill the vacancy caused by the death of Charles D. Noyes.

Mr. Bayliss was educated in the public schools and through the Massachusetts University Extension Courses. After some years of experience as a machinist, he became an operating engineer of both stationary and marine plants.

In 1913 he entered the employ of the Hartford Steam Boiler Inspection and Insurance Company in the Boston office as an inspector of boilers and machinery. In October 1922 he was appointed Directing Inspector and by reason of his ability as demonstrated in this capacity he was made Chief Inspector on March 10, 1924.

Boiler Explosion at Loreauville, Louisiana.

(*Continued from page 51.*)

matter of record that this man and his chief assistant were on duty in the room at the time of the explosion, their bodies having been found at the exact spot in the boiler room where they were last seen alive.

The manufacture of sugar is necessarily a seasonable industry, depending as it does upon annual crops of sugar cane, and the mills are shut down for a considerable portion of the year. This plant was just starting up for the season, the day of the accident being the first day of operation. Some trouble was experienced the previous day with the safety valve of boiler No. 1, the valve having been removed and a new one tested and put in its place. Just what was the trouble has not been made clear, for all of these boilers were thoroughly inspected during the idle season. Trouble must have been experienced again on the day of the accident as we are told that this boiler had been on and off the line several times. It is reported that three different men went to the top of the boiler to make sure that the stop valve was open. Another report is to the effect that trouble was experienced with the feed pump and a higher pressure pump was used.

Examination of portions of the exploded boilers revealed only the extreme violence of the forces released by such explosions, with no indication of the probable cause. The boilers which exploded were Nos. 1 and 2 of a battery of five bagasse burners. All of the rivets in the girth seam between the first two courses of No. 1 boiler were sheared off and the shell was torn along the top from end to end, the rupture passing through the nozzle and manhole openings. The middle and rear courses and rear head were projected about 100 feet to the rear. The front head and portion of the rear course went about a quarter of a mile in the opposite direction. Boiler No. 2 sheared all rivets in the second girth seam, the rear course and head moving about fifty feet back, the front head and front and middle courses and tubes going about 150 feet forward. The hole through the building shown in the picture, just to the left of the mast, marks the path of this larger portion of No. 2 boiler. Boiler No. 3 can be seen in the picture on the extreme left behind the inclined stack where it reposes on top of an oil burning boiler and 125 feet from its original position. In the foreground just over the pair of cart wheels, boiler No. 5 can be seen where it landed approximately 100 feet from its original position. Boiler No. 4 is behind the partition in the center of the picture. All of these boilers were under pressure. The boiler room was completely demolished. It was just in the rear of the three boilers with domes attached lying in the right foreground. It should be explained that these three boilers were in no way concerned with the explosion, for they were taken out of service about three years ago.

Despite the best efforts of reliable operators and inspectors, boilers will explode. In this case the property loss, over $47,000, was covered by a Hartford policy, and was paid within sixteen days after the explosion. The loss from the death and injury cases was covered by workmen's compensation and liability insurance.

Summary of Inspectors' Work for 1923.

Number of visits of inspection made	234,059
Total number of boilers examined	454,079
Number inspected internally	171,016
Number tested by hydrostatic pressure	11,694
Number of boilers found to be uninsurable	1,181
Number of shop boilers inspected	14,609
Number of fly-wheels inspected	46,805
Number of premises where pipe lines were inspected	17,649

SUMMARY OF DEFECTS DISCOVERED.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	33,347	2,059
Cases of adhering scale	49,026	2,002
Cases of grooving	2,239	224
Cases of internal corrosion	26,529	1,085
Cases of external corrosion	13,137	1,248
Cases of defective bracing	1,015	287
Cases of defective staybolting	4,150	916
Settings defective	10,628	1,087
Fractured plates and heads	4,187	630
Burned plates	3,766	531
Laminated plates	302	41
Cases of defective riveting	1,799	566
Cases of leakage around tubes	14,583	2,594
Cases of defective tubes or flues	23,458	8,432
Cases of leakage at seams	5,775	650
Water gauges defective	5,565	984
Blow-offs defective	4,951	1,631
Cases of low water	478	166
Safety-valves overloaded	1,121	312
Safety-valves defective	2,146	489
Pressure gauges defective	8,456	767
Boilers without pressure gauges	1,014	104
Miscellaneous defects	7,946	1,134
Total	225,618	27,939

GRAND TOTAL OF THE INSPECTORS' WORK FROM THE TIME THE COMPANY BEGAN BUSINESS, TO JANUARY 1, 1924.

Visits of inspection made	5,637,574
Whole number of inspections (both internal and external)	11,139,932
Complete internal inspections	4,343,734
Boilers tested by hydrostatic pressure	409,854
Total number of boilers condemned	31,912
Total number of defects discovered	6,166,654
Total number of dangerous defects discovered	683,762

FLY-WHEEL EXPLOSIONS DURING 1923.

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	Jan.	6	Pulley exploded	1		The Hampton Mill		Fordyce, Ark.
2		17	Pulley exploded			J. S. Young Co.		Hanover, Pa.
3	Feb.	6	Fly-wheel of air comp. exploded			Schuylkill Valley Coal Co.	Coal Mine	Pottsville, Pa
4		11	Fly-wheel exploded	1		Reeder's Hotel	Wood saw. Outfit	Stroudsburg, Pa.
5		15	Fly-wheel exploded			Sewell Valley Coal Co.	Coal Mine	Secoma, W. Va.
6		16	Fly-wheel exploded			Seguin Brick & Tile Co.	Brick & Tile Pt.	Seguin, Texas
7		27	Fly-wheel failed			Colton Bros. Co.	Corn & Flour Mill	Bellefontaine, O.
8	Mar.	6	Fly-wheel exploded			Page Electric Light Co.	Power House	Page, N. D.
9		13	Fly-wheel of hydraulic turbine expl'd			City of Dunkirk	Power Plant	Dunkirk, Wis.
10		19	Fly-wheel exploded			Janney Lumber Co.	Lumber Mill	Philadelphia, Pa.
11		20	Fly-wheel exploded		2	Consolidated Gas Co.	Gas Plant	New York, N. Y
12		30	Steam turbine exploded		1	Tuttle & Bailey Mfg. Co.		Brooklyn, N. Y.
13	Apr.	2	Steam turbine exploded		2	Indianapolis Light & Heat Co.	Power Plant	Indianapolis, Ind.
14		14	Fly-wheel exploded			Western White Cedar Co.		Marshfield. Ore.
15		19	Fly-wheel failed			Eureka Ice Co.	Refrigerating Plt.	Houston, Texas
16		25	Fly-wheel exploded			West Chester Cold Sto. & Ice Co.	Refrigerating Plt.	West Chester, Pa
17	May	1	Fly-wheel failed			Wabash Screen Door Co.	Mfgrs. Screens, Stoves, etc.	Minneapolis, Minn.
18		11	Fly-wheel exploded			Cleveland Build. Supply & B. Co.	Builders Supplies	Cleveland. Ohio
19	June	23	Fly-wheel exploded	1		Poor Farm	Farm	Bristow, Okla.
20		30	Blower exploded	6	2	U. S. S. "Williamson"	Destroyer	Newport, R. I.
21	July	2	Pulley exploded	1	1	Singer Co.		Jonesboro, Ark.
22		10	Fly-wheel exploded			Arkansas Brick & Tile Co.	Brick & Tile Plt.	Little Rock, Ark
23		13	Fly-wheel exploded			Public Service Co.		Joliet, Ill.
24	Aug.	7	Pulley exploded			Siskiyou Lumber Co.	Lumber Mill	Medford, Ore.
25		9	Centrifugal oil separator exploded		3	Puget Sound Navy Yard	Navy Yard	Bremerton, Wash
26		16	Fly-wheel and two pulleys failed			Northern Paper Mills	Paper Mill	Green Bay, Wis
27	Sept.	12	Fly-wheels (2) exploded		2	Noble Elec. Lt. & Power Co.	Power Plant	Noble, Ill.
28		20	Fly-wheel exploded	1		Portable Cider Mill		Bellevue, Mich.
29		27	Pulley exploded	1		Choctaw Lumber Co.	Lumber Mill	Bolinger, Ala.
30		28	Fly-wheel exploded		1	Great Western Sugar Co.	Sugar Mill	Bayard, Nebraska

FLY-WHEEL EXPLOSIONS.

(Continued)

No.	MONTH.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
31	Oct.	12	Steam turbine ruptured			City of Durham	Water Works	Durham, N. C.
32		17	Rotor of centrifugal drier exploded			Peoples Sugar Co.	Sugar Factory	Salt L. City, Utah
33		20	Pulley exploded			Arista Mills Co.	Cotton Mill	Winston-Salem, N. C.
34		25	Turbine exploded			Warner Sugar Refining Co.	Sugar Refinery	Edgewater, N. J
35	Nov.	8	Pulley exploded		2	Miller Cabinet Company		Rochester, N. Y.
36			Fly-wheels (2) exploded			Corbin Screw Corp.	Screw Plant	Dayton, Ohio
37		16	Fly-wheel exploded	1	1		Railroad Shops	Fort Worth, Tex
38		19	Fly-wheel exploded		5	Dilworth, Porter & Co.	Spike Mill	Pittsburgh, Pa.
39		20	Band-saw wheel exploded		2	Pacific Spruce Corp.	Lumber Mill	Toledo, Ore.
40	Dec.	1	Fly-wheel of shredding mach. expl'd			Fred Geuther		Crisco, Iowa
41		11	Fly-wheel exploded			Goliad Auto Co.		Goliad, Tex.
42		15	Pulley ruptured			R. B. McEwan & Son	Paper Mill	Whippany, N. J.

BOILER EXPLOSIONS.

(INCLUDING FRACTURES AND RUPTURES OF PRESSURE VESSELS)

MONTH OF APRIL, 1923.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
271	1	Ten sections heating boiler cracked			Grand Theatre	Theatre	Washington, Ind.
272		Two sections heating boiler cracked			David J. Ut	Apartment House	New York, N. Y.
273		Eight tubes failed			Coe Livingstone	Store & Apt. Bldg.	Kent, Ohio
274		Manifold of heating boiler cracked			Eltona Investing Corp.	Apts. & Stores	New York, N. Y.
275	2	Laundry mangle exploded	2	5	Vigilant Laundry	Laundry	Philadelphia, Pa.
276		Boiler exploded		1	Long Beach Dairy & C'm'ry. Co.	Creamery	Long Beach, Cal.

277	3	Two sections heating boiler cracked			John Will Adams	Apartment House	Kansas City, Mo.
278	4	Water-leg butt strap ruptured		1	The Columbus Forge & Iron Co.	Forgings	Columbus, Ohio
279	5	Boiler exploded	1	2	Kippenbrock Farm	Saw Mill	Ferdinand, Ind.
280	6	Boiler of locomotive exploded	2		Lehigh Valley R. R. Co.	Railroad	Duryea, Pa.
281	7	Section of heating boiler cracked			Joseph E. Levy & Sons, Inc.	Apartment House	New York, N. Y
282	8	Boiler exploded		5	Woodland Ave. Bathhouse	Mun. Bathhouse	Cleveland, Ohio
283		Valve burst		1	Batesville Water & Lt. Plant	W. & L. Plant	Batesville, Ark.
284		Tube of locomotive ruptured		3	N. Y. N. H. & H. R. R. Co.	Railroad	Hartford, Conn.
285		Mud drum cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
286	9	Seven sections heating boiler cracked			Second Congregational Church	Church	Holyoke, Mass.
287		Boiler of locomotive exploded	3		Great Northern Ry.	Railroad	Roach, N. D.
288	10	Five sections heating boiler cracked			M. C. Barrett	Garage	Springfield, Mass.
289	11	Tube ruptured			Standard Tire Co.	Tire Works	Willoughby, Ohio
290		Boiler bulged and ruptured			Mowrystown Brick & Tile Co.	Brick & Tile Plant	Mowrystown, O.
291	12	Boiler of locomotive exploded	1		D. B. Gore Strip Mine	Mine	Diam'd Mine, Ky.
292	13	Boiler exploded		1	Yadkin Valley Mill & L'mb'r. Co.	Saw Mill	Ronda, N. C.
293	14	Header cracked			Amicable Life Ins. Co.	Office Bldg.	Waco, Texas
294		Tube ruptured			Eddy Paper Corp.	Paper Mill	Three Riv., Mich.
295		Six sections heating boiler cracked			Luana Corporation	Apartment House	New York, N. Y
296	15	Boiler exploded			Anson Sanitarium	Sanitarium	Wadesboro, S. C.
297	16	Heating boiler exploded		2	Patrick J. O'Neill	Apartment House	Chicago, Ill.
298		Two sections heating boiler cracked			Dumont Paint Mfg. Co.	Paint Factory	Jamaica, L.I., N.Y.
299	17	Twelve headers cracked			Standard Steel Car Co.	Steel Car Works	Hammond, Ind.
300		Boiler bulged and ruptured			J. H. Chambers	Lumber Mill	Cottage Grv., Ore.
301	18	Section of heating boiler cracked			Helen F. Bement	Apartment House	Terre Haute, Ind.
302		Boiler exploded	1	2	Max Sheffield's Saw Mill	Saw Mill	Booneville, Miss.
303	20	Boiler exploded	4	4	J. T. Aycock	Saw Mill	Seffner, Fla.
304		Seven sections heating boiler cracked			Julesburg Heating Co.		Julesburg, Colo.
305		Two sections and manifold of heating boiler cracked			Fourth Atlantic Nat. Bank	Bank	Boston, Mass.
306	22	Boiler ruptured			Vulcan Oil Refining Co.	Oil Refinery	Coraopolis, Pa.
307	23	Boiler exploded	2		Jabe Wells Saw Mill	Saw Mill	Lincolnton, Ga.
308	24	Boiler exploded	1		J. B. Harding Stave Mill	Stave Mill	Batesville, Va.
309		Boiler exploded			Neddam Lumber Co.	Saw Mill	Monroe, La.
310		Boiler exploded			Haley Bakery	Bakery	Great Falls, Mont.
311	26	Boiler of locomotive exploded	2		Lehigh Valley R. R. Co.	Railroad	No. LeRoy Junct., N. Y.
312		Five sections heating boiler cracked			Worcester Baking Co.	Garage	Worcester, Mass.
313		Section of heating boiler cracked			City of Sacramento	Hall of Justice	Sacramento, Cal.

MONTH OF APRIL, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
314	26	Tube ruptured			Pittsburgh Plate Glass Co.	Glass Factory.	Kokomo, Ind.
315	27	Section of heating boiler cracked			Marie Chabanoff	Hotel Apartments	San Franc., Cal.
316		Five sections heating boiler cracked			School Dist. #1, Silver Bow Cy.	School	Butte, Mont.
317	28	Ninety-three tubes pulled out		1	Atlantic Mills of R. I.	Worsted Mills	Olneyville, R. I.
318	29	Tube ruptured		1	E. L. Bruce Lumber Co.	Saw Mill	Memphis, Tenn.
319	30	Boiler of steam automobile exploded			Burr Cooper		Denver, Col.

MONTH OF MAY, 1923.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
320	1	Eight sections heating boiler cracked			Franklin Furniture Company	Furniture Factory	St. Louis, Mo.
321		Tube failed		2	N. Y. N. H. & H. R. R.	Railroad	Hartford, Conn.
322	2	Section of heating boiler cracked			Evansville Paper Box Co.	Paper Box Fact.	Evansville, Ind.
323	3	Evaporator exploded	1	8	U. S. S. New York	Battleship	Los Angeles, Cal
324	4	Tubes ruptured			Eddy Paper Corp.	Paper Mill	Three Rivs., Mich
325		Blow off pipes (2) failed			The Brownell Co.	Boiler Works	Dayton, Ohio
326		Two sections heating boiler cracked			School Dist. of Broken Bow	School	Broken Bow, Neb.
327	5	Section of heating boiler failed			L. & H. Kaplan		Hartford, Conn.
328		Boiler of locomotive exploded		2	D. & H. R. R. Company	Railroad	Tunnel, N. Y.
329	6	Mud drum cracked			Penn. & Ohio Traction Co	Power House	Ashtabula, Ohio
330	7	Boiler exploded	1	2	Larimore Brothers	Saw Mill	Bengal, Okla.
331	8	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
332	9	Vulcanizer exploded			Lawrence Massa	Vulcanizing Plant	Taft, Cal.
333	10	Tube pulled out of tube sheet			Robinson Mfg. Co.	Lumber Mill	Everett, Wash.
334		Boiler bulged and ruptured			Arcadia Mills	Cotton Mill	Spartanburg, S. C.
335		Section of heating boiler cracked			Columbia University Club	Club House	New York, N. Y.
336	11	Section of heating boiler cracked			Weyand-McMahon, Inc.	Garage	Buffalo, N. Y.
337	12	Tube ruptured			Morton Salt Co.		Port Huron, Mich
338		Five headers cracked			Goodyear Rubber Co.	Rubber Goods Pt.	San. Franc., Cal.
339	14	Boiler exploded	2	1	C. D. Whitefield Lumber Co.	Lumber Mill	Lake, Miss.
340	15	Boiler exploded	2	2	Grendel Mills	Cotton Mill	Greenwood, S. C.
341		Boiler exploded	1	1		Oil Well	Iowa Park, Tex.
342		Section of heating boiler cracked			John Mayer	Apartment House	Kansas City, Mo.

343	16	Section of heating boiler cracked			Moses Ottinger	Apts. & Store	New York, N. Y
344	17	Five tubes pulled out of drum		1	Bethlehem Steel Corp.	Steel Plant	Lackawanna, N. Y.
345	18	Tube pulled out of tube sheet			Kansas City Laundry Service Co.	Laundry	Kansas City, M
346		Eight headers cracked			City of Baltimore	Asylum	Baltimore, Md.
347	19	Thirteen tubes pulled out of drum			General Motors Corp.	Automobile Plant	Flint, Mich.
348	20	Section of heating boiler cracked			Florence G. McKeever		New York, N. Y
349	21	Compressed air tank exploded			Pacific Coast Glass Works	Glass Factory	San Franc., Cal
350		Hot water heater exploded			Frank Falango	Barber Shop	San Jose, Cal.
351	22	Fitting on steam main failed			Theo. Fathauer Co. of Ark.	Saw Mill	Helena, Ark.
352	23	Hot water boiler exploded		1		Apartment House	San Franc., Cal
353	25	Boiler exploded	3	1	W. H. Cauley	Saw Mill	Elba, Ala.
354	26	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
355		Ten staybolts of crown sheet failed			Greenville & Shelmerdine Ry. Co.	Railroad	Greenville, N.
356	28	Compressed air tank exploded			United Tire & Supply Co.	Garage	Kansas City, Mo
357	29	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
358		Two tubes ruptured			Allegheny Steel Co.	Tin Plate Mill	Harrison Twp., P
359		Boiler exploded	1	1	Stovall Drilling Co.	Oil Well	Fairbanks, La.
360	30	Boiler exploded			Bennett Injector Co.	Factory	Muskegon, Mich
361	31	Boiler exploded	1	1		Threshing Mach.	Canton, Ohio
362		Boiler exploded	1		Scott Farm	Saw Mill	Jeffersontown, Ky
363		Header cracked			Monsanto Chemical Co.	Chemical Works	St. Louis, Mo.
364		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.

MONTH OF JUNE, 1923.

365	1	Section of heating boiler cracked			Manhattan Exhibition Co., Inc.	Theatre	New York, N. Y.
366		Three sections heating boiler cracked			Hyde Mfg. Company	Optical Mfg.	Southbridge, Mass
367		Manifold of heating boiler cracked			William A. Fox	Theatre	Jamaica, L. I.
368	3	Boiler exploded		2	Klauser Company	Oil Well	Long Beach, Cal
369	4	Boiler ruptured			Southern Pine Products Co.	Wood By-Products	Hattiesburg, Miss.
370	7	Blow off pipe accident			John Schneider Milling & Bak. Co.	Bakery	Cincinnati, Ohio
371	8	Crown sheet of locomotive collapsed			J. Neils Lumber Company	Lumber Mill	Klickitat, Wash.
372	9	Steam main burst			New York Steam Corp.	District Heating	New York, N. Y.
373	10	Header cracked			Pittsburgh Plate Glass Co	Glass Factory	Ford City, Pa.
374		Tube ruptured		1	Trevorton Colliery Co.	Coal Mine	Trevorton, Pa.
375	11	Boiler exploded	1	2	Banks & Thomas	Gin & Saw Mill	Richlands, N. C.
376		Boiler exploded	2	1	Gulf Production Co.	Oil Well	Wortham, Texas

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1923

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks	$507,869.87
Real Estate	255,000.00
Mortgage and collateral loans	1,818,750.00
Bonds and stocks	8,414,500.82
Premiums in course of collection	1,029,559.34
Interest Accrued	140,348.10
Total assets	$12,166,028.13

LIABILITIES

Reserve for unearned premiums		$5,530,427.71
Reserve for losses		318,407.05
Reserve for taxes and other contingencies		457,030.70
Capital stock	$2,500,000.00	
Surplus over all liabilities	3,360,162.67	
Surplus to Policyholders,		**$5,860,162.67**
Total liabilities		$12,166,028.13

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Trustees, United States Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Vice-President, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.
SAMUEL M. STONE, President, Colts Patent Fire Arms Mfg. Co. Hartford, Conn.
SAMUEL FERGUSON, President, The Hartford Electric Light Co., Hartford, Conn.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Incorporated 1866 Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, GA.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abel Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Ct.,	W. G. Lineburgh & Son, General Agents.
404-405 City Savings Bank Bldg.	A. E. Bonnet, Chief Inspector.
CHICAGO, Ill.,	
209 West Jackson B'v'l'd	P. M. Murray, Ass't Manager.
	J. P. Morrison, Chief Inspector.
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio.	W. E. Gleason, Manager.
First National Bank Bldg.	Walter Gerner, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chesnutt,
916-918 Gas & Electric Bldg.	Manager and Chief Inspector.
HARTFORD, Conn.,	F. H. Kenyon, General Agent.
56 Prospect St.	A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector.
Hibernia Bank Bldg.	E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y.	C. C. Gardiner, Manager.
80 Maiden Lane	E. Mason Parry, Chief Inspector.
	R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	Wm. J. Farran, Consulting Engineer.
	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	Bates, Lively & Pearson, Gen'l Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
301 Thomas Bldg.	
SAN FRANCISCO, Cal.,	H. R. Mann & Co., General Agents.
339-341 Sansome St.	J. B. Warner, Chief Inspector.
ST. LOUIS, Mo.,	C. D. Ashcroft, Manager.
310 North Fourth St.	Eugene Webb, Chief Inspector.
TORONTO, Canada,	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.
Federal Bldg.	

CARNEGIE LIBRARY
DEC 1 - 1924
OF PITTSBURGH, PENNA

SOMETHING LARGER

⁂

Sad is the day for any man when he becomes absolutely satisfied with the life he is living, the thoughts that he is thinking and the deeds that he is doing, when there ceases to be forever beating at the door of his soul a desire to do something larger which he feels and knows he was meant and intended to do.

PHILLIPS BROOKS

Reprinted from "The Equiowa."

CARNEGIE LIBRARY
DEC 1 - 1924
OF PITTSBURGH, PENNA

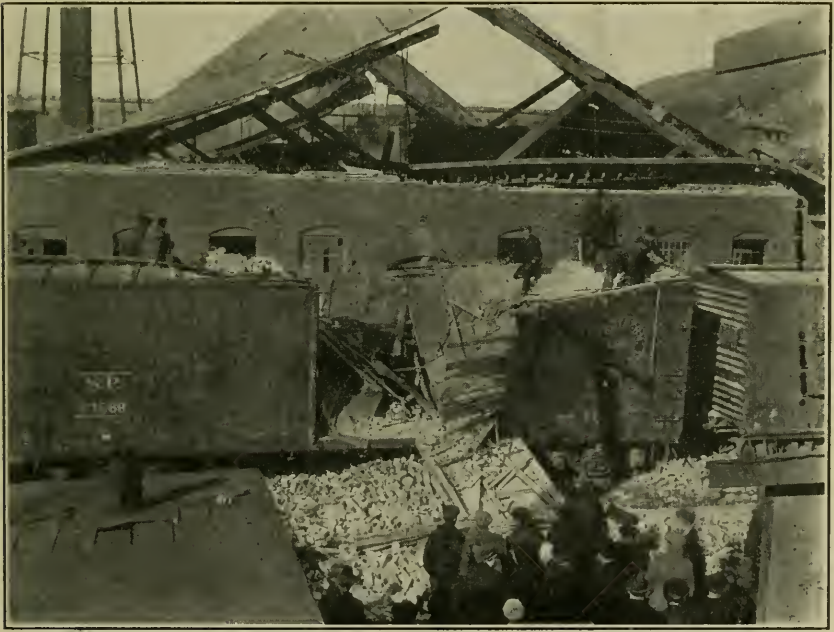
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXV. HARTFORD, CONN., JULY, 1924. No. 3

COPYRIGHT, 1924, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



PAPER MACHINE DRYING CYLINDER EXPLOSION AT QUINCY, ILL.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Explosion of a Paper Machine Drying Cylinder.

A DISASTROUS explosion occurred February 29, 1924 in the plant of the North Star Strawboard Mills at Quincy, Illinois, when one or more of the drying cylinders on a paper machine failed. Two men were killed and eight injured, the property loss being estimated at $100,000. An exterior view of the plant after the explosion is shown on our front cover.

Authentic data are not available regarding this explosion and newspaper accounts of the inquest show conflicting testimony. It appears that each machine was equipped with two safety valves set to relieve at 60 pounds pressure. The allowable pressure was said to be 50 pounds, with 20 and 25 pounds the usual working limits. The pressure was regulated by an automatic regulator. There were some rumors that excessive pressure was being carried in order to speed up production, one witness at the inquest stating that the guages indicated 120 pounds shortly before the accident. Others reported having heard the safety valves blow at different times. The evidence indicates, however, that any increase in pressure above normal was due entirely to the operators and was not in conformity with any orders.

The accident apparently was not without warning. Two men, for instance, who were at work in the room at the time were able to escape injury by running from the room at the first signs of trouble. A workman in another room testified to having heard a blowing of steam followed by two distinct explosions, while still another witness heard a low rumbling sound preceding the main explosions.

An examination of one of the ruptured cylinders indicates the accident to have been a result of water-hammer, which would seem entirely possible in view of the fact that water is always present in a greater or lesser quantity in these cylinders. Had the machine just been started up, conditions for the formation of water-hammer would have been almost ideal. The violence of the explosion would indicate that a pressure higher than the stated working pressure was being carried.

A double acting Diesel engine is being developed in England for marine work. The experimental engine has but one cylinder and is approximately 31-½ inches diameter by 55 inches stroke. It is proposed to build these engines as six or eight cylinder units, developing 600 brake horse-power per cylinder.

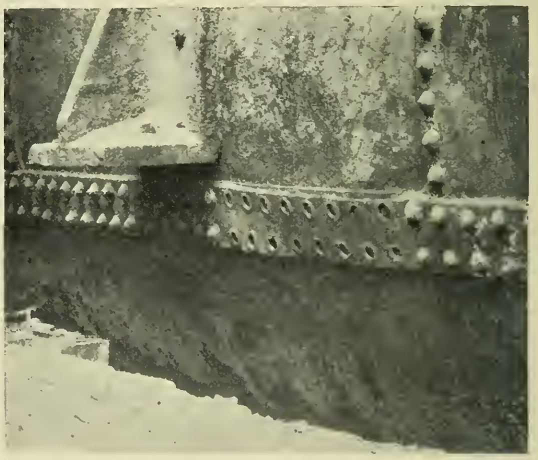
The Value of Inspections.

IN pointing out some of the advantages of inspection service, we have frequently emphasized the seriousness of the defects found. There have recently come to our attention, however, several instances of defects in boilers located by members of our inspection staff and which are of particular interest because of certain incidents attending their discovery. Most of them undoubtedly would have been passed over by men not specially trained and experienced in boiler inspection work, as several required not only all of the skill and resourcefulness at the Inspector's command, but also courage and tenacity such as perhaps few can lay claim to.

One such incident was the direct result of an unofficial visit on the part of the Inspector. It had been his practice to call at the various plants in his territory whenever he happened to be in the vicinity in order to keep in touch with the engineers and the conditions at the plants. On one of these visits, which was made particularly to find out when a certain boiler would be available, the engineer remarked that the digestors were not in service just then and that it might be a good time to inspect them. By availing himself of the opportunity thus offered, the Inspector made an interesting and timely discovery. One of these digestors, which was constructed with five courses each 48 inches long, had a patch on one of the courses at the lap seam longitudinal joint and running the full length of the course. At the caulking edge of the patch, about midway betwen the girth seams, there apparently had been some leakage but, in preparing the digestors for laying up, the plates had been cleaned for painting and the leakage stains almost obliterated. In fact they would not have attracted any particular attention had not the patch been slightly bulged, a condition which the Superintendent said had existed for some time. The Inspector felt that something was wrong and requested that a hand hole be cut through the sheet and that a small portion of the lining be removed. A lap seam crack was revealed which ran practically the full length of the patch.

On another occasion, while inspecting two water-tube boilers in a power station, an Inspector found what appeared to be an inside crack in the mud drum. It was not continuous but was visible for a distance of approximately 1½ inches, then a space of perhaps ½ inch then the crack again. The Chief Engineer of the plant thought it was light corrosion, and stated that he was not afraid of it. The inspector, however, was not satisfied and asked the Engineer to have the defective part of the shell thoroughly cleaned. Later, assisted by another Inspector, a re-examination was made with the aid of a magnifying glass, and an inside crack was revealed into which the blade of a pen-knife could be thrust about 3/16 of an inch. A defect of the same nature was discovered in the corresponding drum of the other boiler.

Again, a general inspection of an horizontal return tubular boiler brought to light signs of distress at several points in one of the longitudinal seams. Two rivet heads were snapped off and there was evidence of leakage at four different places. From the inside of the boiler the seam appeared to be in good order, but the Inspector was not satisfied. He requested that a sufficient number of bricks be removed to make the seam accessible on the outside. The joint was of double butt strap construction, and an examination of the outside disclosed that the outside butt strap did not lie close to the shell plate. This is shown clearly in the accompanying illustration. At several points where the strap had been forced away from the shell, a heavy rust deposit was evident in between, indicating that the plates were somewhat reduced by corrosion. The removal of sixteen rivets proved this to be the case, besides bringing to light the fact that five rivets had been broken. Owing to the condition of this seam and the age and type of boiler, its replacement was recommended.



A Defective Butt Strap Discovered By Inspection.

A water-tube boiler, operating at 225 lbs. pressure, had just been placed in service after repairs to the furnace had been completed. On receiving notice that the Inspector desired to make an internal inspection, it was immediately taken out of service and prepared for the inspection. Slight indications of leakage at the girth seam of one drum were evident, closer examination also revealing a crack running from a rivet hole to the edge of the plate. Superheaters, which were located within three inches of the drum, made difficult a satisfactory examination of the girth seam. The Inspector, however, thought it quite likely that more cracks existed and so requested the removal of ten rivets. The surrounding plate was then cleaned with acid, whereupon it became evident that similar cracks existed in seven of the ten holes. Upon removal of all the rivets up to the buttstraps on each side, it was found that 44 rivet holes were thus impaired. There were nine boilers in this battery and the turbine room was adjacent to the boiler room, from which we may obtain some idea of the probable loss had this defective boiler not been rigidly inspected at the time.

A short while ago an Inspector was sent to look over some leaky tube ends at a plant housing two 150 h.p. boilers operating at 120 lbs. pressure. On arrival at the plant, one boiler was found in operation at but 80 lbs. pressure and with the four inch tubes leaking badly. Inquiry developed that the tubes had been rolled several times and made tight to water pressure, but that steam pressure of 80 or 90 lbs. immediately started them leaking again. The outside of the boiler was heavily covered with lagging so that not much was to be seen except the tube ends and fire sheets. The Inspector, however, felt that the trouble needed careful investigation, particularly in view of the fact that it was located under a hotel with a moving picture theater and stores on the first floor. He accordingly requested the removal of the four inch tubes and suggested that in the meantime not over 15 to 20 lbs. pressure be carried on the other boiler. An inspection after these tubes had been removed revealed that fourteen of the cross braces were broken and that the flat side-plates of the boiler were bulged out about 1½ inches. Subsequent removal of the three inch tubes revealed that 21 of the 35 braces were broken. A new boiler was recommended.

Serious external corrosion of the mud drum of a boiler, which by the way was twenty-five years old, was brought to light recently by the removal of the bridge wall and brick work in front of it. The bottom sheet of the drum, for a distance of 18 inches circumferentially and running its entire length, had deteriorated until it was but 3/16 inch thick from an original thickness of ½ inch. The rivet heads were also considerably reduced, and a hydrostatic test showed that several of them were cracked. The condition in which this boiler was found led to the inspection of several others in the same plant with similar results though the defects were of a less dangerous degree.

Most defects of a very serious nature give some visible evidence of their presence, though this evidence, as in some of the cases cited, is very faint. In one case which came to our attention, however, with everything appearing sound and in good condition, the Inspector, by means of the hammer test, discovered twenty-two broken staybolts.

Frequently the Inspector must labor for hours, and almost invariably in a most uncomfortable position, in order to satisfy himself as to the condition of a boiler. One such instance which stands out occurred in the examination of a fire tube boiler. The only visible defect was a deeply pitted rivet. The setting of the boiler was of such a nature that the hammer and light could not be used to advantage. The Inspector desired to investigate further, however, and so constructed a chisel of special shape with which to pick off the rust. Lying on his back in a small furnace, he manipulated this instrument for two and one half hours. When this rusty scale had been removed, he was able to rip open the shell for a distance of approximately eight inches, the plate having been almost entirely eaten away.

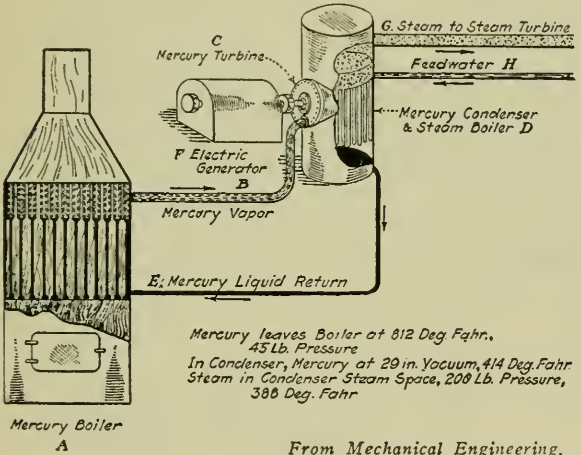
A somewhat similar experience was had by an Inspector when called to investigate leakage around the bottom of a rear head seam. The through rods at the rear were so close together that it was next to impossible to reach the head, but by turning on his side the Inspector was able to wedge in close enough to pick at the scale. The scale at this point was about ½ inch thick and very hard. After spending considerable time in this constrained position removing the scale, the Inspector found that the head at the flange had wasted away until it was but 1/16 inch thick. A deep dent could be made with each blow of a light hammer. The scale had been so thick and hard that it supported the head plate. It is interesting to note in connection with this incident that an external inspection just two weeks previous failed to give any indication of the dangerous condition of this boiler.

The Mercury Vapor Boiler and Turbine.

THE possible use of mercury as an auxiliary working fluid for the production of power in central stations is attracting the attention of everyone interested in the generation of power. This interest is world-wide if we may judge by the articles appearing in the technical press, and apparently ranges from the scientist, interested in the theory of the thermodynamic cycle, to the operating engineer, whose interest lies primarily in the mechanical details of the apparatus and in its operation. Attention has been directed to this new development in the field of power generation by announcement of the installation of the first commercial size unit of the kind in the Dutch Point Station of the Hartford Electric Light Company, Hartford, Connecticut.

This radical departure from standard power plant design is a result of over ten years of study and experimentation by W. L. R. Emmet of the General Electric Company. The theory upon which it is based, however, cannot be termed new as the possibilities of using two working fluids have been frequently suggested, and at least one such engine was built and operated. This engine utilized sulphur dioxide as the second working fluid and operated on the other end of the steam cycle, that is, steam was first generated and, in being condensed, was caused to evaporate the sulphur dioxide. The invention was not developed commercially because of the apparent high cost of installation and maintenance.

The principle of operation of the mercury vapor plant is very simple. Mercury, as we know, is a liquid and, like any other liquid, is capable of being evaporated. The process, therefore, begins with a boiler filled to the proper " water " level with mercury. The mercury is boiled off into vapor (mercury " steam ") which is carried off by a main to the turbine. After performing its work in the turbine, the vapor is condensed in a surface condenser, the condensate then being returned to the boiler, just as would be done in any steam plant. It is interesting to note at this point that no feed pump is necessary as the turbine is located above the boiler and the weight of the mercury is such that it will return to the boiler by gravity. The heat given up by the mercury in condensing is sufficient not only to heat up the condensing water but also to actually turn it into steam and at a pressure of 200 pounds. This steam is turned into the regular steam main of the plant and completes its cycle by passing through the turbines, thence to the condenser and hot well, and back to the boiler as feed water. Fig. 1 is a diagram of the apparatus and gives an idea of the relations existing between the various elements.

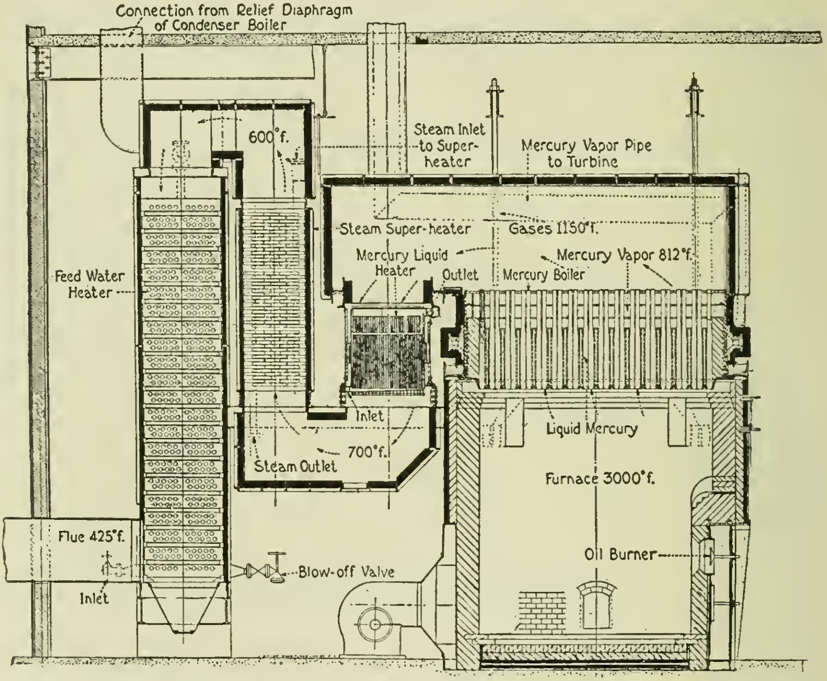

G. Steam to Steam Turbine
C
Mercury Turbine
Feedwater H
Mercury Condenser & Steam Boiler D
F Electric Generator
B
Mercury Vapor
E: Mercury Liquid Return
Mercury leaves Boiler at 812 Deg. Fahr., 45 Lb. Pressure
In Condenser, Mercury at 29 in. Yacuum, 414 Deg. Fahr.
Steam in Condenser Stzam Space, 200 Lb. Pressure, 388 Deg. Fahr
Mercury Boiler
A

From Mechanical Engineering.

FIG. 1.

The object of using mercury is that the heat may be transferred from the flue gases and retained in the working substance at as high a temperature as possible. For instance, at 250 lbs. pressure, the temperature of saturated steam is 406°F., whereas the temperature of mercury vapor at but 35 lbs. pressure is 812°F. To attempt to produce steam at this temperature would require pressures and superheats which are generally considered impractical. The mercury vapor can be utilized at as low pressure as steam, the temperature at 28 in. vacuum being 457°F.

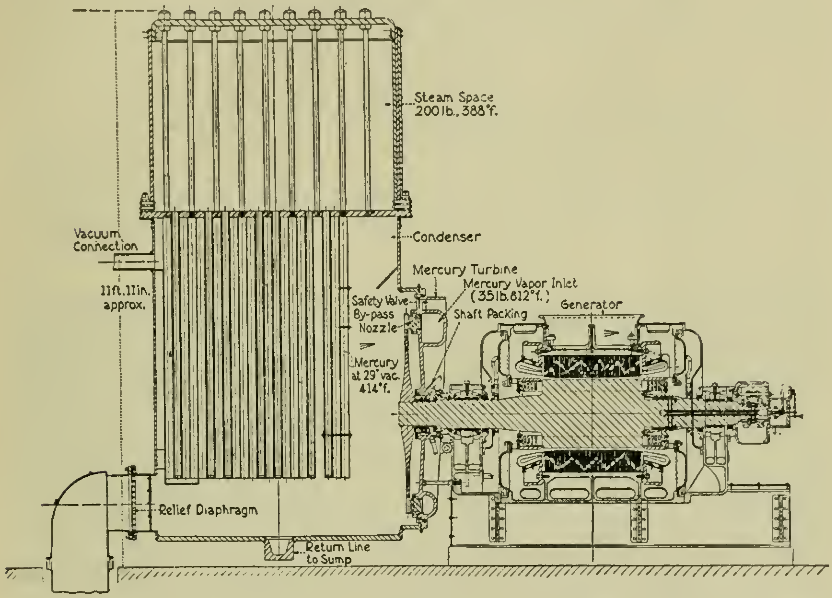
The first experimental apparatus of this type was erected in the laboratories of the General Electric Company at Schenectady, N. Y., about ten years ago. The Hartford unit was installed in the fall of 1923 and is said to be the fifteenth design, changes being made with the object of reducing the mercury content. The details of the unique plant are given in Figs. 2 and 3. In general appearance it is so unlike the orthodox steam plant that one is at a loss to understand the layout without either having the drawings before him, or else a guide to explain the details. The combination of mercury units,— boiler, economizer, condenser, and turbo-generator — and of steam units, — boiler, superheater and economizer — all joined together as one unit, is indeed confusing. The heat originates in an oil burning furnace beneath the



From Mechanical Engineering.

FIG. 2.

mercury boiler. This boiler is of unusual design in that it has but one flue sheet. The tubes are expanded into the upper flue sheet as usual in vertical tubular boilers, and are suspended therefrom. The lower portions of the tubes, for about two-thirds of their entire length, are of enlarged diameter and become hexagonal instead of round. The increase in diameter is such that the tubes touch one another and each six tubes enclose a passage between them. The end of this passage is sealed over and the ends of the tubes are welded together so that there is no lower tube sheet. This construction takes care of the unusual expansion due to the higher temperatures, and gives a large heating surface with small volume of liquid.



From Mechanical Engineering.

FIG. 3.

After passing through this boiler, the hot gases pass in turn through a mercury liquid heater (economizer), steam superheater, and a water heater or economizer, thence to the stack. The mercury vapor turbine and condenser (steam boiler) are located on a platform above the boiler. The vapor, therefore, travels up from the boiler to the turbine, and, on being condensed, flows by gravity back to the boiler. The turbine is of an ordinary single wheel type. The steam is not utilized in any particular unit, but, as explained previously, is turned into the regular steam main at 200 pounds pressure.

As a working fluid, mercury has certain advantages as well as disadvantages. Its pressures and volumes at the desired working temperature are found very convenient to deal with. Its latent heat, however, is low. At atmospheric pressure it is but one-eighth that of steam. Although at the working pressures the difference is not quite so great, yet not less than seven pounds of mercury must be condensed to evaporate one pound of water.

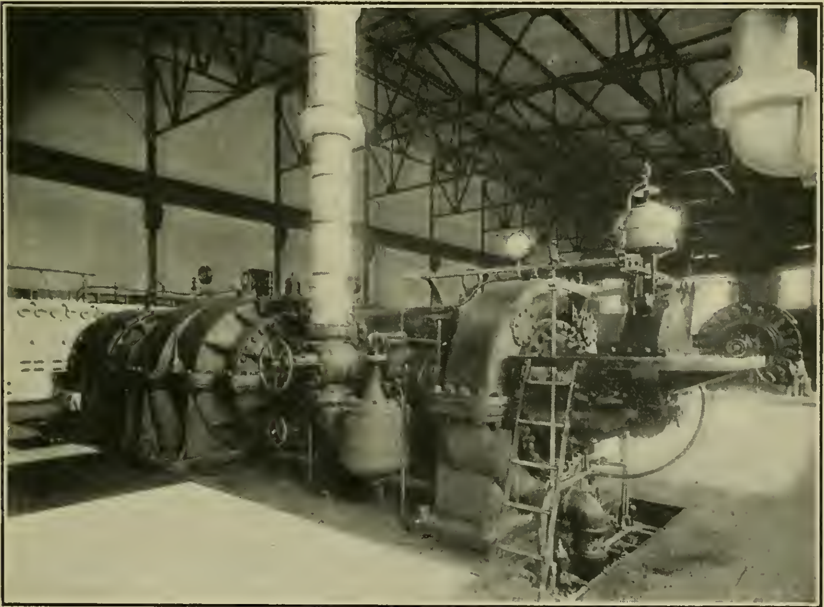
A serious problem which had to be solved before this new working substance could be used was the question of leakage. Mercury has been quite properly called "quicksilver," for it is hard indeed to confine under pressure. Joints and materials that appear sound to steam and water will often allow it to escape. Now while a leak in a steam pipe is undesirable primarily because of the heat loss, in the case of mercury vapor the results are more far reaching. In the first place this vapor is reputed to be poisonous, so that for this reason alone leaks cannot be tolerated. Then too it is a very expensive substance. The problem of leakage, however, was readily overcome by welding, making an absolutely closed system.

An interesting but rather pessimistic viewpoint of this new process is presented by the *Engineering & Mining Journal-Press,* which points out the world's limited visible supply of mercury ore. An engineer is trained to rely on figures, and so it would seem as if these statistics ought to dampen the enthusiasm of those primarily interested in the development of this new power plant. But a more optimistic view, however, is held by many experienced persons as pointed out by Mr. Emmet in his paper presented at the May meeting of the American Society of Mechanical Engineers. We are also told that the limited demand has resulted in production from only the most favorable sources. The richest ore is not mined because of the liability of poisoning the men, and the low grade ore is not mined on account of the cost. At double the present market price, the supply is thought to be unlimited. Perhaps, too, those primarily interested in this development are influenced by an abiding faith in mankind such as was once expressed by Dean Kimball of Cornell University — "When man needs something, he usually finds a supply, as, for instance, radium and oil." In the early days of oil it is said the apparent end of the supply caused some hesitancy about investing much money in refineries, and also resulted in the first oil burning locomotives being designed for quick conversion to coal burners. It has also been brought to our attention that not very many years ago the visible supply of aluminum consisted of about two ounces displayed under glass in the British Museum.

This power generating unit has been in service for several months, and has been operating on a twenty-four hour schedule in a highly satisfactory manner. It is shut down occasionally for inspection and because of minor mechanical and electrical troubles, but up to the present time we understand the process itself has never given any trouble whatever. It is interesting to compare the experiences of setting this new piece of commercial power plant equipment into operation with those had in starting up the first commercial steam turbine, which incidentally was installed in another plant of this same company nearly a quarter of a century ago. An account of the early experiences with this turbine is given in the following article.

First Commercial Steam Turbine in This Country.

IF we only knew what the future held in store, there would be no need in our language for the word "confidence." Speculation as to success or failure would be replace by absolute knowledge. At the present time, power engineers are speculating as to the probable success to be attained by the new mercury vapor process of producing power. In attempting to forecast, we usually turn to history, and, as representing one of the most recent revolutionary developments in



Photograph by Courtesy of The Hartford Electric Light Co.

First Commercial Steam Turbine In This Country.

power plant practice, the history of the steam turbine is of particular interest. The following account, reprinted from *Power,* is taken from a letter read at a meeting of the Technical Section of the National Electric Light Association recently held in Boston. This letter was read by one of the executives of the Hartford Electric Light Company, Hartford, Conn., and gives some of the incidents connected with the installation and operation of the first commercial steam turbine in this country which took place in one of the plants of that company.

"This unit was 1,500 kw. 2,400-volt, two-phase, 1,200 r. p. m.; dimensions as follows: Height, about 7 ft.; width, approximately 7 ft.; weight, about 100 tons. This unit arrived in Hartford in January, 1901, and was moved from the siding to Pearl Street during the night time on rolls through the streets, so as not to obstruct traffic. The turbine being assembled, the truckmen did not have any trucks or apparatus that would support it. Upon arrival, the Westinghouse erectors were on the job ready to place it on the foundations prepared by the company. Owing to no condensing water outside of the city water, which was of course out of the question to use, cooling towers were erected to take care of condensation. This necessitated the purchase of more land on Pearl Street, which is now occupied by the Library Bureau. These towers were three in number. The auxiliary power to take care of the barometric condenser attached to this unit was as follows: One 300-h.p. pump for water to condenser, one 300-h.p. pump to pump the condensation and circulating water through the three cooling towers. On these cooling towers were three 40-h.p. direct-current fans.

"The total auxiliary power to take care of this unit was 40 per cent of its rated output, but apparently they underrated this unit, as the writer, during a short period test, has seen 6,000 kw. registered in the indicating wattmeter, and this on the primary valve. We really had no way of getting the full capacity from the unit.

"The erecting of the unit, and also boilers, consumed the greater part of the year, and finally, about the latter part of October or the fore part of November, 1901, the turbine made its initial bow to the public, it being the first commercial turbine installed in the United States, and from that time on we had some trials and tribulations that surely gave no end of trouble, and not until the year 1903, after the Westinghouse engineers had been on the job two years without missing a day, they found that to get this turbine to perform more than one full day at a time, the whole low-pressure blading had to be removed and the balancing pistons on the high-pressure end were likewise removed.

This, of course, cut down the efficiency very much. The turbine did run after this with more 24-hour periods. It was in trouble so many times, the upper case having been removed so many times, that the bolts and nuts were stretched so badly that three sets had to be used. During 1902 the shaft became loose in the spindle on the high-pressure end and a new one was ordered and was pressed in by hydraulic pressure, but during this process the pump failed when the shaft was within ⅜ inch of its true position. This necessitated shipping from the factory one load of special machinery to obviate the trouble. This took weeks to straighten out.

" During the first year the turbine ran 84 hours; during the second, 555; during the third, 721; during the fourth, 2,173.

" During 1901 (est.) 80,000 kw.-hr. were generated; during 1902, 429,000; during 1903, 616,200; during 1904, 2,462,350.

" In 1905 the machine was moved to our Dutch Point Station and operated there until 1908, when it was replaced by a new turbine. This (first) turbine, when started up, was found to be too long between bearings and owing to sagging of the spindle, the blading would be ripped out. The cap had to be removed, and blades that were broken out were removed and the cap replaced. This being a continuous performance, this work had to be done two or three times a week. After this had gone on too far, our thrust bearing would not stand the work placed upon it and it would fail. This necessitated the placing of new blades in the case and rotor, and this followed each year until 1903. When we lost blades in the turbine, we had to have them cleaned out so that it could be operated the next day for our peak load.

" Owing to our records during these early years having been destroyed, I am unable to give you a clear and authentic report of its daily performance, but I can safely say that during its first two years of existence, if we had 48 hr. of continuous operation, we thought we had a wonder.

" At the present time, this turbine is located at Pittsburgh, to give some idea of the great improvements made in turbines since that time."

Stresses in Bolts Due to Setting Up

THE initial stress, or that stress which is present in a bolt due to " setting it up," is seldom thought of when determining the proper size of bolt to carry a specified load. And yet we are told by those who have investigated the subject that this initial " setting up " stress is quite frequently the maximum produced in a bolt. To a person who has not given the subject much thought this statement appears fallacious

— that apparent additional load placed upon an already loaded member does not increase the stress therein — but a little reflection will show us that there is some foundation for it.

There are two generally accepted cases, one in which the actual load on the bolt does not materially increase the stress therein, and a second in which the actual load does so increase it. Whether a given bolt will fall into the one class or the other will depend upon the nature of the joint, that is, the elasticity of the two pieces connected by the bolt. If we have, for instance, two cast iron flanges in metal to metal contact, the bolts would "give" or stretch more than the flanges would be compressed. Such a joint would be a case in class one. But, should a gasket be interposed between the two pieces connected, then the joint would be more elastic than the bolt and we would have a case in class two, in which the load directly increases the stress in the bolt.

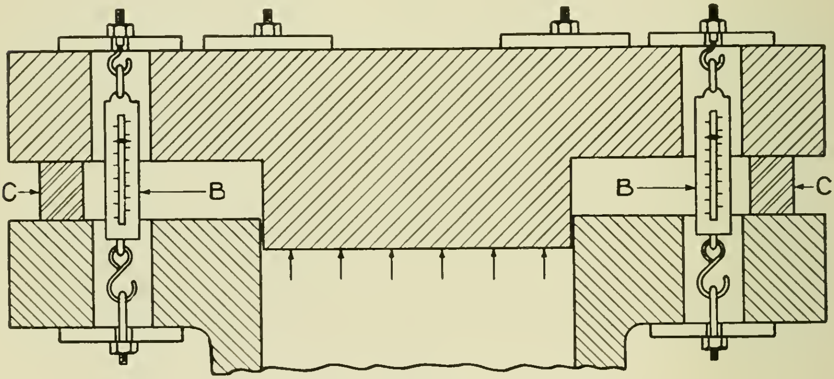


Fig. 1.

In order to make clear just why there is this difference, let us consider a simple illustration. In Fig. 1 we have a steam cylinder, but instead of a gasket between the cylinder and cylinder head we have a plain iron hoop. This hoop resists the pressure caused by screwing up on the bolts, and if it is divided into the same number of parts as there are bolts, then each section or block can be considered in connection with a single bolt. Special bolts, each containing a spring-balance as illustrated, will also be used. The pressure on each block, therefore, will be the pressure indicated by the spring-balance bolt. Now suppose steam is admitted. The immediate effect is to relieve the pressure on the blocks, but no increase in tension in the bolts will occur until the cylinder head actually moves. This would not occur, of course, until the pressure due to the steam exceeded the pressure on the blocks (initial stress) which is a case we are not now considering.

It might not be amiss to pause right here to remind our readers that this illustration is perhaps more accurate than some might think, for a bolt is just as truly elastic and acts exactly the same as the spring. If we examine the scale on a spring balance we will observe the pointer travels a certain distance for say 5 lbs., twice as far for 10 lbs., three times as far for 15 lbs., and so on. In other words, the movement is directly proportional to the load, and the same is true for a bolt. Most bolts being short, the stretch under a load is almost imperceptible, but each inch of length stretches the same amount so that if a bolt were long enough we could substitute it for the spring in a spring balance.

Perhaps another way of illustrating this might make the point more clear. Imagine a spring balance suspended with a 10 lb. weight on the pan. The scale reading will be 10 lbs. Now attach a cord to the bottom of the pan and pull down upon this cord, fastening it so that the scale reading will be 25 lbs. It is quite evident that but 15 lbs. pull must be exerted on the cord to attain this result.

Let us now assume that our cord is absolutely inextensible, which means that it will not stretch under a load, and that there will be no springing or stretching of any of the other parts of our system due to loading. Such being the case, remove the 10 lb. weight. Everything will remain exactly the same except that the string will now be exerting 25 lbs. pull.

Or, looking at it in a way which possibly will make the analogy to the actual bolt more clear, start with the spring balance empty and pull down on the cord until the scale reads 25 lbs. This represents the tension in the cord. Now place the 10 lb. weight on the scale pan. It will be seen that the tension in the cord is reduced to 15 lbs., but the scale reading remains unchanged.

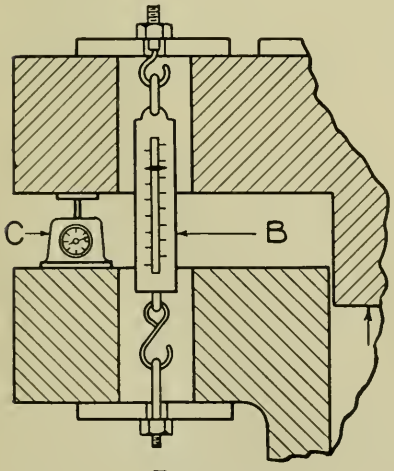


Fig. 2.

Likening this to a bolted joint, the spring represents the bolt, the cord represents the plates joined by the bolt, the 25 lbs. represents the initial tension in the bolt due to setting up, and the 10 lbs. represents the load placed on the joint. A moment's reflection will make it clear why the added load (10 lb.

wt.) did not increase the tension in the bolt (spring balance).

On the other hand, let us see what happens when we have an elastic joint, as when a gasket is interposed. For this we will use the apparatus shown in Fig. 1 except that the incompressible blocks will be replaced by the same number of spring scales, as shown in Fig. 2. Screw down on the bolt until the balances read say 25 lbs. This represents the initial stress. If steam is now turned into the cylinder, it will be apparent that some outward movement of the head will result, since the joint is not a rigid one but is carried by the balanced forces of two elastic or readily yielding springs. The effect will be to increase the tension in the bolts, some decrease in the pressure on the scale C also taking place. Thus any load on a non rigid joint serves to immediately increase the stress in the bolts.

It can readily be seen that in any case should the steam pressure be great enough to entirely relieve the pressure on the blocks A of Fig. 1, or the scales C of Fig. 2, the cylinder head would be entirely off its seat and would therefore leak steam.

The only difference between the two cases illustrated above, that is the elastic and the non-elastic joints, lies in the difference between the actions of the inextensible cord and the spring which later replaced it As a matter of fact, such a cord is impossible, for everything, no matter of what material it may be made, will " give " when stressed. We may then say the difference is merely one of relative deformation under load of the bolt and of the parts connected, the one case really merging into the other.

An excellent analytical study of these stresses in bolts, and also rivets, is given by R. Fleming in *Engineering and Contracting* for March 24, 1920. For the purpose of explaining his method, we are again going to make use of spring balances as offering the easiest conception of deformation proportional to load.

Using the set up shown in Fig. 2, screw down on the bolt nuts until some considerable pull is indicated on the balances. Then raise the steam pressure sufficiently to cause the cylinder head to move out until the two scales, B and C, read the same. (This is merely taking care of the weight of the various parts which would otherwise place an additional load upon one balance. The same result would have been attained by assuming that these parts had no weight). Call this scale reading the initial tension, Ti.

Starting with an identical reading on both scales B and C, again raise the steam pressure until the reading of C is considerably decreased. This tension in B. we will call load tension, Tm. The terms with which we will deal in this discussion will then be:

Tm = total tension in bolt (B) when loaded.
Ti = total initial tension in bolt (B)
d_1 = deformation of spring B due to Tm
d_2 = " " " C " " Ti
$d_1 - d_2$ = " " " B " " Ti
E = modulus of elasticity.

Since, as previously explained, the deformation of the bolt (B) is proportional to the load, then

$$\frac{Tm}{Ti} = \frac{d_1}{d_1 - d_2}$$

$$\text{or} \quad Tm = \frac{Ti}{1 - \frac{d_2}{d_1}} \qquad \text{(I)}$$

For any given load, the tension (Tm) would exceed the initial tension (Ti) by the amount (Tm—Ti), which from equation I gives:

$$(Tm - Ti) = Tm - Tm\left(1 - \frac{d_2}{d_1}\right)$$

$$= Tm\left(\frac{d_2}{d_1}\right) \qquad \text{(II)}$$

When load Ti is on both springs, then

$$\frac{\text{movement of } B}{\text{" \quad " } C} = \frac{d_1 - d_2}{d_2} = \frac{\dfrac{\text{length } (B)}{\text{area } (B) \times E}}{\dfrac{\text{length } (C)}{\text{area } (C) \times E}} \qquad \text{(III)}$$

If the springs are of the same length and material (conditions approximated in an actual joint), then "length" and "E" (modulus of elasticity) will drop out and the equation will be:

$$\frac{d_1 - d_2}{d_2} = \frac{\text{area } (C)}{\text{area } (B)}$$

$$\text{or} \quad \frac{d_1}{d_2} = 1 + \frac{\text{area } (C)}{\text{area } (B)} \qquad \text{(IV)}$$

(It is true that in equation III the cross-sectional areas of the springs might be equal, but this would not be true in the case of a bolted connection and so we will consider them unequal in our illustration.)

Equations I and IV enable us to find the total tension in the bolt in terms of the initial tension. An examination of equations I or II shows us that the stress in a bolt when loaded in the manner under consideration will always exceed the initial stress, for in order to be otherwise it would be necessary that $d_2 = 0$. This, of course, is impossible. But, it is possible to increase the contact area of the flanges, thus reducing the unit pressure and thereby reducing the deformation — in other words, making d_2 approximate zero.

An idea of the amount of increase may perhaps be obtained from a concrete example. Let us suppose a 1″ bolt joins two iron plates each 1″ thick. The area of a 1″ bolt at root of threads is .55 square inches and is area (B) of equation IV.

In determining "area (C)" it is considered that the force is transmitted through the plates by the portion of the metal forming two truncated cones. The smaller base of each is equal to the area covered by the nut or bolt head, the sides flaring out at 45° as indicated in Fig. 3. "Area (C)" is the mean of the two bases.

$$\text{Distance across flats of } 1'' \text{ bolt} = 1\tfrac{5}{8}''$$

$$\text{Mean diameter of cone} = (1\tfrac{5}{8} + 1)$$

$$\text{and area} = .785(2.625)^2$$

$$= 5.41 \text{ sq. in.}$$

Substituting in equation (IV)

$$\frac{d_1}{d_2} = 1 + \frac{5.41}{.55}$$

$$= 10.84$$

$$\text{and } \frac{d_2}{d_1} = .092$$

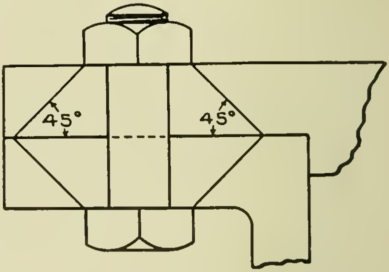


Fig. 3.

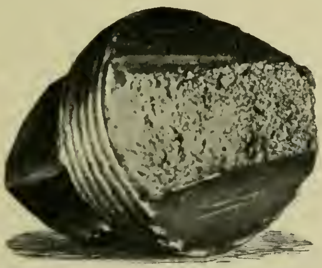
This value in equation II shows that for this *particular* condition only 9% of the total stress is due to load. Or substituted in equation I, it shows that the stress in the bolt is constant at 1.10Ti until the load alone exceeds this value. The stress is then, of course, the load itself. Other conditions give slightly higher values, but we are assured that the increase over the initial stress is never more than 10 or 12% so long as the load tension is not excessive.

Actual values of the stresses due to "setting up" are difficult to determine. If the efficiencies of screw threads were accurately known, a fair estimate might be made. Various tests would indicate that approximately 10% of the force theoretically produced with the wrench might be expected to actually appear in the bolt. As an illustration, it is recorded that at Cornell University some years ago in a series of tests to ascertain the pressure necessary to make a steam joint tight a ½″ bolt was wrenched off. Assuming a tensile strength of 60,000 lbs. per square inch for the bolt, and that an 8″ wrench was used, a little computation will show that less than 12 lbs. pull on the wrench would produce this tension in the bolt if the efficiency were 100%.

The actual pull likely to be exerted upon this size bolt is a variable depending upon its accessibility and upon the mechanic. If we make a further assumption for this and say that the pull exerted to wrench it off was 100 lbs., the efficiency would then be but 12%. Certain it is that but for this large loss in friction many bolts would have been stressed to failure before the load they were intended to carry had been placed upon them.

It is unusual, however, if we except fatigue failure, to find a bolt failing due to direct tension. Instead we find many failures due to the threads stripping off. This is not altogether surprising for although the threads are designed with a greater factor of safety than the body, yet there is what might be termed an additional factor of safety entering into the one as against a destructive action on the other.

The body or shank of a bolt is designed sufficiently strong for a given service by computing its strength based on the smallest cross-section, that is, based on the area at the root of the threads. A threaded specimen, however, is somewhat stronger than a plain cylindrical specimen of the same material. This is attributed to a reinforcing action of the threads. We know that when a rod is subjected to tension it increases in length and decreases in cross-sectional area. This decrease in area must be gradual, that is, spread over some appreciable length. The threads on the bolt tend to prevent this reduction in area, first because the space between threads is not great enough to allow it to properly take place, and second because the greater amount of metal in the threads being under less unit tension does not contract as much itself and so acts to prevent the grooved portions from reducing. The net result of this reinforcing action under *static* loading is an increase of about 14% in the strength of a bolt over that of a plain cylinder of cross-sectional area equal to the area at root of the threads* — and this despite the stress concentration at the roots of the threads.


STAYBOLT END, SHOWING HOW THE DEEP INCISIONS OF THE NIPPERS PREVENTED "NECKING DOWN."

The threads, on the other hand, are being continually weakened through the action of the nut, especially in cases where the parts are frequently disconnected. When a nut is run on and off it receives a certain amount of rough handling and misusage with the wrench,

---

*Cathcart's Machine Design.

(*Continued on Page 86*)

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, Editor. B. C. CRUICKSHANKS, Assistant Editor.

HARTFORD, JULY, 1924.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

THE wonderful results often attained by intensive farming methods are at times held up in contrast to the more natural methods in so wide use, and the continuation of the latter deplored. The former, however, entails greater investment and requires greater effort on the part of the operator. So long as land values are such that ordinary farming methods show a profit, these methods will be followed. When it is found that land must yield increased products in order to show a profit, then will a greater yield be required of it.

Likewise, it has been expressed as a matter of regret that our timber is being used at the present rapid rate for the production of wood pulp when paper can be made of a great many other materials which are now wasted. Grasses, linters, corn stalks, bagasse, and many other fibrous vegetable products have been suggested, but here again it is an economic question. Costly special processes, developed only after much experimentation, would be required. As the wood pulp supply decreases with resultant increased prices, development of other sources of supply will be financially justified.

We are now witnessing just such a condition in the power industry. It might be called a "critical point." Increasing demand for coal has resulted in increasing prices as well as difficulties in transportation and storage. In an effort to reduce the quantity used, much has been done toward increased efficiency through the study of combustion, the use of boiler room instruments, and improved boiler design. Not much additional gain is to be expected through such means. Accordingly, through the development of new processes, efforts are being made to radically increase the theoretical amount of heat available for use. Today there are three new processes, which, in the experimental stage, have given such promise of success that commercial size units are in varying stages of building. Two of these processes contemplate the use of extremely high pressures, while the third makes use of two working fluids. The latter, the Emmet Mercury-Vapor Process, is already in commercial operation. The initial installation is described elsewhere in this issue.

Stress in Bolts.

It is perhaps a common fallacy to consider that the only stress in the bolts holding a cylinder head or flange is that imposed by the pressure of the liquid, gas or vapor within the vessel. Contrary to this idea, we may say that the stresses are always greater than the value so obtained, but just how much greater depends upon the nature of the joint. We believe that our readers will find considerable food for thought on this subject in the article entitled "Stresses in Bolts Due to Setting Up" which appears on page 77 of this issue of The Locomotive.

PERSONAL.

AT the spring meeting of the American Society of Mechanical Engineers, held at Cleveland, the nominating committee included in their recommendations for officers for the ensuing year the name of Mr. S. F. Jeter, Chief Engineer of this Company, as one of the Vice-Presidents.

We congratulate the Society in having included Mr. Jeter among the other most excellent nominees. We feel that the Society has conferred a distinct honor upon Mr. Jeter who has so long displayed a keen and sustained interest in the affairs of the Society, having been Chairman of the Hartford Section, a Manager of the Society, and for eleven years a member of the Boiler Code Committee. By reason of his achievements and personality, his selection will prove a popular one.

We extend to all the nominees our heartiest congratulations.

"STATION KDKA, Westinghouse Electric & Manufacturing Company, Pittsburgh, ... we are to have a talk by Mr. J. A. Snyder on the subject 'The Special Value of Steam Boiler Inspection and Insurance.' Mr. Snyder is Chief Inspector of the Hartford Steam Boiler Inspection & Insurance Company."

Thus ran the announcement from this well known broadcasting station on the evening of May 19th when Mr. J. A. Snyder, Chief Inspector of our Pittsburgh Department, took a most effective means of explaining the value of boiler inspection and insurance. This talk was given in conjunction with the convention of the Insurance Federation of Pennsylvania, then in session in Pittsburgh. Those who were able to " tune in " were rewarded — we speak from experience — by hearing a very entertaining and instructive lecture. We congratulate Mr. Snyder both upon the excellence of his talk and upon the honor which has come to him in being, we believe, not only the first Hartford man to talk over the radio, but also the first person to broadcast on the subject of steam boilers.

Stresses in Bolts Due to Setting Up

(*Continued from page 83.*)

particularly when there is a tendency to overtighten in order to make a tight joint. Then there is the natural wear, and the looseness of fit desired to make it go on and off easily. Also any imperfections in mating, as for instance a slight difference in lead, would practically throw the load entirely on one thread until it was distorted sufficiently to permit others to share the load. All of these have the effect of gradually breaking down the threads with the result that bolts often fail by stripping.

Recognizing the destructive effect of frequently setting up and loosening bolts, this Company, in cases of bolts subjected to such use, recommends that the maximum stress not exceed 6,000 lbs. per sq. in. at the root of the threads.

Since the initial stress is frequently such a large part of the total load on a bolt, and particularly in view of the damaging effect on the threads of over tightening, it would seem that in many cases good use might be made of some such admonition as is placed on certain ordnance material — " These nuts should not be tightened more than with the combined strength of two men exerted upon the wrench provided for this purpose without a pipe or other means of extending its length."

Summary of Boiler Explosions For 1921 and 1922.

SUMMARY FOR 1921

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	63	9	16	25
February . . .	47	9	12	21
March	46	2	25	27
April	45	17	14	31
May	32	5	14	19
June	37	4	10	14
July	45	19	35	54
August	36	52	73	125
September	40	10	36	46
October	89	6	23	29
November	60	15	18	33
December	80	10	36	46
Total for 1921 .	620	158	312	470

SUMMARY FOR 1922

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	116	19	41	60
February	60	5	12	17
March	81	15	42	57
April	54	2	10	12
May	42	14	28	42
June	36	16	13	29
July	50	3	31	34
August	39	18	34	52
September	54	13	27	40
October	66	5	32	37
November . . .	67	13	31	44
December . . .	88	9	31	40
Total for 1922 .	753	132	332	464

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JUNE, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
377	13	Section of heating boiler cracked			Stag Realty Corp.	Hotel and Stores	Holyoke, Mass.
378	14	Blow off pipe failed			Garden Canning Co.	Canning Factory	Evansville, Wis.
379		Hot water heater cracked			W. F. & M. F. Blasse	Apartment House	San Franc., Cal.
380	15	Tubes pulled out of tube sheet			Atlas Drop Forge Co.	Drop Forge Plant	Lansing, Mich.
381		Section of heating boiler cracked			Colonial Apartment House	Apartment House	Omaha, Neb.
382	16	Header cracked			Dover Mfg. Co.	Elec. Iron Plant	Dover, Ohio
383	17	Section of heating boiler cracked			Moses Ottinger	Apartment House	New York, N. Y.
384		High pressure air line exploded			Weirton Steel Co.	Steel Mill	Weirton, W. Va.
385	18	Boiler ruptured		1	Southern Pine Products Co.	Wood By-Products	Hattiesburg, Miss.
386	19	Boiler of automobile exploded			Emmet Garver	Automobile	Chicago, Ill.
387	21	Tube failed			Libby, McNeill & Libby	Packing House	Morrison, Ill.
388		Inner shell of drier collapsed		2	Carstens Packing Co.	Packing House	Tacoma, Wash.
389	22	Boiler exploded	1	1	Tippin Farm	Saw Mill	Acworth, Ga.
390	26	Tube ruptured			Bastrop Pulp & Paper Co.	Paper Mill	Bastrop, La.
391		Tube ruptured	2	2	City of Atlantic	Light & Pump. Pt.	Atlantic, Iowa
392	27	Blow off pipe failed			Model Bakery & Restaurant	Bakery & Rest'ant	Louisville, Ky.
393		Blow off pipe failed			Union Ice & Storage Co.	Ice & Cold Stor.	Lamar, Col.
394	28	Boiler exploded	2	2	Lake Cypress Lumber Co.	Towboat	Madisonville, La.
395	29	Boiler exploded	4	1	J. D. Bridges	Saw Mill	Sumner, Ga.

MONTH OF JULY, 1923.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
396	3	Flue plug of locomotive blew out		2	Chi., R. I. & P. Ry. Co.	Railroad	Harrah, Okla.
397	4	Main steam line exploded			American Steel & Wire Co.	Wire Mill	Anderson, Ind.
398	5	Tube ruptured		1	Consumers Power Co.	Power Plant	Jackson, Mich.
399	7	Boiler exploded. Failed at autogenous weld		1	R. G. Gingery	Dry Cleang. Plant	Miles City, Mont.
400		Mud drum cracked			Ohio Power Co.	Power Plant	Lima, Ohio.

401	8	Header cracked			Cott A. Lap Co.	Linoleum Factory	Somersville, N. J.
402	9	Non-return valve ruptured			Keasby & Mattison Co.	Asbestos Plant	Ambler, Pa.
403	11	Compressed air tank exploded		5	Sykes Automotive Ry. Equip. Co.		Waukegan, Ill.
404		Hot water heating boiler exploded			Charles Deroga	Barker Shop	Huntington Beach, Calif.
405		Crown sheet failed	1	7	Missouri Pacific R. R. Co.	Railroad Co.	Nevada, Mo.
406	12	Blow-off pipe failed			407 E. 91st Realty Corp.	Laundry	New York, N. Y.
407	13	Boiler of locomotive exploded	1	1	Chicago & Eastern Ill. R. R. Co.	Railroad	Salem, Ill.
408		Boiler ruptured			Tabor Laundry	Laundry	Portland, Ore.
409		Tube pulled out of header		1	Knickerbocker Ptld. Cement Co.	Cement Plant	Hudson, N. Y.
410		Tube ruptured			Kingsport Utilities, Inc.	Power Plant	Kingsport, Tenn.
411	14	Boiler of locomotive exploded	2	1	Chi. & No. Western R R Co	Railroad	Belle Plaine, Ia.
412		Section of heating boiler cracked			New Orleans Country Club	Club House	New Orleans, La.
413		Header cracked			Pittsburgh Plate Glass Co	Glass Factory	Crystal City, Mo.
414		Header cracked			Pittsburgh Terminal Warehouse & Transfer Co.	Power House	Pittsburgh, Pa.
415		Tube ruptured			Calvert Water, Ice & Elec. Lt. Co.	Power Plant	Calvert, Texas
416	15	Carbonated gas tank exploded	1		John Bennett	Restaurant	Universal, Ind.
417	17	Washout plug of locomotive blew out		2	Norfolk & Western R. R. Co.	Railroad	E. Portsmouth, O.
418		Crown sheet failed	1	1	France Stone Co.	Stone Quarry	Monroe, Mich.
419	18	Vulcanizer exploded	1		Auburn Rubber Co.	Tire Factory	Auburn, Ind.
420		Boiler of locomotive exploded		3	Central of Georgia Rwy. Co.	Railroad	Macon, Ga.
421		Boiler explosion	2	2	W. R. Hawkins	Saw Mill	Whitleyville, Tenn.
422	19	Boiler exploded	1	1	King Bros.	Saw Mill	Coleta, Ala.
423		Boiler exploded			W. E. Pigg	Slaughter House	Pittsburg, Kan.
424		Safety valve ruptured			Spreckels Sugar Co.	Steamer	San Francisco Bay, Calif.
425	21	Three sections of heating boiler cracked			Niagara Concrete Mixer Co.	Concrete Mixers	Buffalo, N. Y.
426	22	Tube ruptured		2	Riverside Fibre & Paper Co.	Paper & Pulp Mill	Appleton, Wis.
427		Two sections heating boiler cracked			H. C. Whitmer Co.	Medicines	Columbus, Ind.
428	23	Boiler exploded		3	Koch Lumber Co.	Shingle Mill	Wilmington, N. C.
429	24	Hot water heater exploded			Williams College	College	W'mstown, Mass.
430	25	Boiler exploded		1	Humble Co.	Oil Well	Corsicana, Tex.
431	26	Hot water heater exploded	1		Indiana Condensed Milk Co.	Cond. Milk Plant	Lebanon, Ind.
432	27	Boiler ruptured			Baron Co. Canning & Pickle Co.	Canning Factory	Chetek, Wis.
433		Two sections heating boiler cracked			Washburn Co.	Wood working	N. Bedford, Mass.
434		Crown sheet failed	1		White Oil Corporation	Oil Refinery	Oil City, La.
435		Boiler exploded			Pratt's Saw Mill	Saw Mill	Houston, Tex.
436	29	Boiler of locomotive exploded	1	1	Lehigh Valley R. R. Co.	Railroad	White Haven, Pa.

MONTH OF JULY, 1923 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
437	29	Ten tubes ruptured			Saginaw Salt Products Co.	Salt & Chem. Wks.	Carrollton, Mich.
438	30	Ammonia liquor pipe and expansion valve failed			Peoples Ice & Cold Storage Co.	Refrigerating Plt.	Omaha, Neb.
439	31	Compressed air tank exploded		2	Broad Ripple Line	Street Car	Indianapolis, Ind.

MONTH OF AUGUST, 1923.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
440	1	Steam pipe exploded			Philip Dietz Company	Ice Plant	Ridgewood, N. Y.
441		Crown sheet of tractor failed		1	H. Hunter Farm	Tractor	Buda, Ill.
442	2	Blind flange ruptured			Kissel Motor Car Co.	Automobile Facty.	Hartford, Wis.
443		Tube ruptured			Peoples Ice & Cold Storage Co.	Refrigerating Plt.	Omaha, Neb.
444	4	Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
445		Boiler bulged and ruptured			Metropolitan Paving Brick Co.	Brick Factory	Canton, Ohio
446		Tube collapsed			Noyes & Hall	Canning Factory	Dexter, Me.
447		Boiler ruptured			Capital Ice Co.	Ice Plant	Oklahoma City, Okla.
448	5	Tube pulled out			Calvert Water & Lt. Co.	Ice, Lt. & Water Plant	Calvert, Tex.
449	5	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
450	6	Header cracked			Nueces Hotel Company	Hotel	Corpus Christi, Tex.
451		Boiler of locomotive ruptured		2	Excelsior Cypress Company	Saw Mill	Thibodeaux, La.
452		Main steam line ruptured			Winston-Salem Chair Co.	Chair Factory	Winston-Salem, N. C.
453		Two tubes ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
454	7	Boiler exploded	1		Monarch Tobacco Co.	Tobacco Factory	Louisville, Ky.
455		Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
456	8	Tube ruptured			Bryant Paper Co.	Paper Mill	Kalamazoo, Mich.
457		Compressed air tank exploded			Anaconda Copper Mining Co.	Copper Mine	Butte, Mont.
458	9	Blow-off pipe failed		1	City Water Works	Pump House	Monmouth, Ill.
459		Tube ruptured		2	Robinson Mfg. Co.	Lumber Mill	Everett, Wash.
460		Heating boiler exploded		1	Henry J. Lange	Apartment House	New York, N. Y.

461		Blow-off pipe failed		1	City of Monmouth	Pumping Station	Monmouth, Ill.
462	10	Boiler ruptured			Wismer Box Co.	Lumber Mill	Tillamook, Ore.
463		Crown sheet failed			E. D. Tyner Construction Co.	Contractors	Kansas City, Mo.
464	11	Rendering tank exploded			Sibley Rendering Plant		Lake Park, Iowa.
465		Tube ruptured			Kansas City Power & Lt. Co.	Power Plant	Kansas City, Mo.
466	12	Fitting on steam main failed			Middlewest Utilities Co.	Power Plant	Ashland, Wis.
467	13	Compressed air tank exploded		2	Hyman Haskell & Sons	Stone Yard	Brooklyn, N. Y.
468		Laundry mangle exploded	1	1	New Haven Steam Laundry	Laundry	New Haven, Conn.
469		Header ruptured	1		Nueces Hotel Co.	Hotel	Corpus Christi, Tex.
470		Tube ruptured			Wilson Syndicate Trust Bldg.	Office Building	Dallas, Tex.
471	14	Boiler exploded	1	4	Geo. Buchanan's Farm	Saw Mill	Barbersville, Ind.
472		Boiler exploded		1	Fred Snoozy Farm	Threshing Mach.	Centerville, S. D.
473		Boiler exploded		1	John Forman	Threshing Mach.	Vernon, Col.
474	15	Boiler exploded	1	4	Edward Kinkaid	Saw Mill	Shelby Twp., Ind.
475	16	Crown sheet of locomotive failed			Bowman-Hicks Lumber Co.	Lumbering	La Grande, Ore.
476	17	Boiler of locomotive exploded	1	4	Atchison, Topeka & Santa Fe Ry.	Railroad	Alvin, Texas.
477	18	Section of heating boiler cracked			Louville V. Niles	Apts. and Store	Boston, Mass.
478		Boiler bulged and ruptured			Consumers Ice Co.	Ice Plant	Dallas, Texas.
479	19	Boiler of locomotive exploded	1	3	N. Y., N. H. & H. R. R. Co.	Railroad	Walpole Hts., R. I.
480	20	Boiler burned and ruptured			Campbellsville Ice & Cream Co.	Creamery	Campbellsville, Ky.
481		Tube ruptured			Swift-Hunter Lumber Co.	Saw Mill	Atmore, Ala.
482		Unfired steam vessel exploded			U. S. Smith Bakery	Bakery	Fayette, Ohio.
483		Boiler ruptured		7	Archer's Laundry	Laundry	Baltimore, Md.
484		Compressed air tank exploded		8	American Car & Foundry Co.	Foundry	Milton, Pa.
485		Boiler exploded	1	2	Hub Harper	Saw Mill	Longview, Tex.
486	21	Stop valve ruptured			Astoria Silk Works	Silk Mill	Long Island City, N. Y.
487		Tube ruptured and headers (3) cracked			Omaha Ice & Cold Storage Co.	Refrigerating Plt.	Omaha, Neb.
488		Tube ruptured			Lakeside Hospital	Hospital	Cleveland, Ohio.
489		Section of heating boiler cracked			Lubliver & Trinz	Theatre	Chicago, Ill.
490	25	Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
491		Man-hole cover of boiler blew off			General Ice Company	Ice Plant	Shelbyville, Tenn.
492	26	Heating boiler exploded			Pryor Baking Co.	Bakery	Penbrook, Pa.
493		Boiler of locomotive exploded	2	1	Baltimore & Ohio R. R. Co.	Railroad	Bond, Md.
494	28	Crown sheet of locomotive failed			Gulf Sabine & Red River R. R.	Railroad	Fal, La.
495		Accident to steam main			Schmidt & Ault Paper Co.	Paper Mill	York, Pa.
496		Locomotive dry-pipe collapsed			North State Lumber Co.	Lumber Mill	Charleston, S. C.

MONTH OF AUGUST, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
497	28	Tubes failed			Park Place Family Laundry Corp.	Laundry	Norfolk, Va.
498	30	High pressure air line exploded			Weirton Steel Co.	Coal Mine	Republic, Pa.
499	31	Boiler exploded	1		W. R. Bonsal & Co.	Contractor	Lilesville, N. C.

MONTH OF SEPTEMBER, 1923.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
500	1	Arch tube of locomotive pulled out of flue sheet		3	Long Island R. R. Company	Railroad	No. Shore, L. I.
501		Section of heating boiler cracked			Marks Hat Company	Business Block	Des Moines, Ia.
502	3	Boiler exploded	1	15	Pulaski Iron Works		Pulaski, Va.
503	5	Boiler exploded	1	2	McDonald Brothers	Oil Well	Richland, Tex.
504		Tube ruptured			Wilson Syndicate Trust Bldg.	Office Building	Dallas, Tex.
505	6	Boiler exploded	1	1	Wright Lumber Co.	Saw Mill	Lufkin, Texas.
506		Boiler ruptured			Greenwell Bros.	Ice Plant	Morganfield, Ky.
507	7	Boiler exploded	1	4	Houston Farm	Farm	Carl Junc., Kan.
508		Jacketed rendering tank collapsed		1	Consolidated Rendering Co.	Rendering Plant	Pawtucket, R. I.
509	8	Valve burst		1	Reed Bros.	Dairy	Memphis, Tenn.
510		Tube ruptured		1	Tipton Farmer Canning Co.	Canning Factory	Tipton, Iowa.
511		Boiler ruptured			Co-operative Dairy Ass'n.	Dairy	Kansas City, Mo.
512	9	Blow-off pipe failed			J. J. Leeth & Sons	Cotton Gin	Hico, Texas.
513		Blow-off pipe failed			Rice Lake Excelsior Co.	Excelsior Factory	Rice Lake, Wis.
514	10	Boiler of locomotive exploded	3		St. Louis-San Francisco Ry. Co.	Railroad	Valley Cntr., Kan.
515		Fitting on steam main burst			Swift-Hunter Lumber Co.	Saw Mill	Atmore, Ala.
516	11	Tube ruptured			City of Memphis	Water Works	Memphis, Tenn.
517	12	Section of heating boiler cracked			School District No. 8	School	Blackfoot, Idaho.
518		Boiler ruptured			Palestine Gin Co.	Cotton Gin	Palestine, Tex.
519	13	Boiler ruptured			McHenry Cannery		Modesto, Calif.
520		Boiler ruptured			Henneberger Ice & Cold Stg. Co.	Refrigerating Plt.	Mt. Carmel, Ill.
521	14	Alum cooking tank exploded		4	Merrimac Chemical Co.	Chemical Plant	Everett, Mass.
522	15	Section of heating boiler cracked			Waterbury Club Holding Corp.	Club	Waterbury, Conn.
523		Boiler bulged and ruptured			Hazelwood Co., Ltd.	Creamery	Spokane, Wash.
524	16	Hot water heater exploded		4	211 Cedar Street	Residence	Reading, Pa.

525	17	Boiler exploded			Fresh Meadow Country Club	Country Club	Flushing, N. Y.
526		Nine sections of heating boiler cracked			Town of West Hartford	Public School	W. Hartford, Ct.
527		Boiler bulged			Mishawaka Farmers Dairy Co.	Milk Station	Mishawaka, Ind.
528	18	Section of heating boiler cracked			N. S. Wilson	Apt. House	Denver, Colo.
529	19	Stop valve ruptured		1	American Pulley Co.	Pulley Mfg.	Philadelphia, Pa.
530	21	Boiler exploded	2		Joe Baldwin	Cotton Gin	Carthage, Texas.
531		Section of heating boiler cracked			Broadway Cent'l Securities Corp.	Offices & Stores	New York, N. Y.
532	22	Boiler exploded		4	S. S. William F. Herrin	Oil Tanker	Avon, Calif.
533		Fire-box ruptured			Veness & Shives	Logging	Timber, Ore.
534		Section of heating boiler cracked			First Baptist Church	Church	Du Quoin, Ill.
535	23	Steam pipe burst		1	Missouri Pacific R. R. Co.	Railroad Shop	Baring Cross, Ark.
536	24	Boiler of locomotive exploded	1	1	C., R. I. & P. R. R. Co.	Railroad	Biddle, Ark.
537		Fitting on main steam line failed			Lawrence S. Holt & Sons	Cotton Mill	Burlington, N. C.
538		Blow-off pipe failed			Hill County Cotton Oil Co	Cotton Oil Mill	Italy, Texas.
539	25	Tube ruptured			General Motors Corporation	Automobile Facty.	St. Louis, Mo.
540	26	Boiler exploded	2		Howell's Mill	Saw Mill	H'w'll's Spur, Ala.
541		Air tank exploded			Burkland & Terry	Garage	Philadelphia, Pa.
542	28	Tube ruptured			Michigan Alkali Co.	Manufacturing	Wyandott, Mich.
543	29	Two tubes pulled out of superheater			Arkansas Utilities Co.	Power Plant	Helena, Ark.

MONTH OF OCTOBER, 1923

544	1	Section of heating boiler cracked			William J. Fitzsimmons Co.	Residence	Scranton, Pa.
545		Section of heating boiler cracked			Red Top Cab Company	Taxicab Co.	Cleveland, O.
546		Tube ruptured			Woodward Iron Company	Blast Furnace	Woodward, Ala.
547	2	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
548		Header ruptured		1	Spreckels Sugar Company	Sugar Refinery	Spreckels, Cal.
549		Fitting on feed line ruptured			Worcester Elec. Light Co.	Power Plant	Worcester, Mass.
550	4	Boiler exploded			Alpy Box Co.		Newark, N. J.
551		Boiler exploded			Alan Jay Parrish	Residence	Paris, Ill.
552	5	Section of heating boiler cracked			Edwin A. Boss	Hotel	Algona, Ia.
553	6	Boiler bulged and ruptured			Alexander Ice & Coal Co.	Ice Plant	Franklin, Ind.
554		Section of heating boiler cracked			Chas. Seidman	Necktie Factory	Philadelphia, Pa.
555	7	Three sections heating boiler cracked			The Monarch Company	Mercantile & Mfg.	Stamford, Conn.
556	8	Section of heating boiler cracked			Ramsey Realty Company	Apartment House	New York, N. Y.
557		Crown sheet of locomotive failed			Snow Creek Logging Company	Lumbering	Blyn, Wash.
558	9	Boiler ruptured			Parker-Davenport Co.	Hotel	Norwich, Conn.
559		Boiler exploded			Senator Bayard	Residence	Washington, D. C.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1923

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$507,869.87
Real Estate	255,000.00
Mortgage and collateral loans	1,818,750.00
Bonds and stocks	8,414,500.82
Premiums in course of collection	1,029,559.34
Interest Accrued	140,348.10
Total assets	$12,166,028.13

LIABILITIES

Reserve for unearned premiums		$5,530,427.71
Reserve for losses		318,407.05
Reserve for taxes and other contingencies		457,030.70
Capital stock	$2,500,000.00	
Surplus over all liabilities	3,360,162.67	
Surplus to Policyholders,		**$5,860,162.67**
Total liabilities		$12,166,028.13

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Trustees, United States Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Vice-President, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Vice-President and Treasurer, Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.
SAMUEL M. STONE, President, Colts Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, President, The Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866 — THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. — Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, GA., 1103-1106 Atlanta Trust Bldg	W. M. Francis, Manager. C. R. Summers, Chief Inspector
BALTIMORE, Md., 13-14-15 Abel Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Ct., 404-405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'v'l'd	P. M. Murray, Ass't Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	A. Paul Graham, Manager. L. T. Gregg, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J. H. Chesnutt, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, General Agent. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y. 80 Maiden Lane	C. C. Gardiner, Manager. E. Mason Parry, Chief Inspector. R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickkam, Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrot Bldg.	Geo. S. Reynolds, Manager. I. A. Snyder, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	Bates, Lively & Pearson, Gen'l Agents. C. B. Paddock, Chief Inspector.
SEATTLE, Wash., 305-306 Thompson Bldg.	C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
TORONTO, Canada, Federal Bldg.	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.

CARNEGIE LIBRAR
DEC 1 - 1924
PITTSBURGH, PEN

ELECTRICAL MACHINERY INSURANCE

Inspections made by HARTFORD ELECTRICAL INSPECTORS are of the same thorough character as those that have made HARTFORD BOILER INSPECTIONS the standard for comparison.

A Hartford Electrical Policy

PROTECTS against loss due to
- Burnouts
- Short Circuits
- Lightning
- Mechanical Breakage
- Explosion from overspeed
- Etc.

INSURES
- Rotating Machinery
- Transformers
- Switchboards
- Etc.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER
INSPECTION and INSURANCE CO.
HARTFORD CONNECTICUT

"The *oldest* in the Country, the *largest* in the world"

CARNEGIE LIBRARY
1924
OF PITTSBURGH

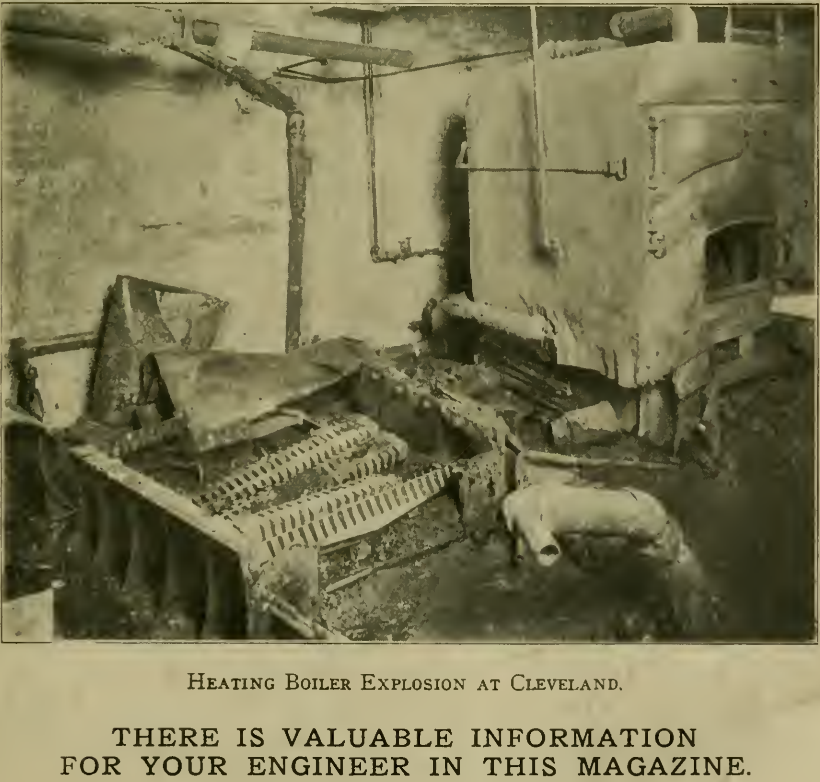
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXV. HARTFORD, CONN., OCTOBER, 1924. No. 4

COPYRIGHT, 1924, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



HEATING BOILER EXPLOSION AT CLEVELAND.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

A Hot Water Heating Boiler Explosion at Cleveland.

THE explosion of a hot water heating boiler in the basement of a wood working shop in Cleveland recently resulted in the death of one man and the serious, probably fatal, injury of another. The boiler was a vertical cast iron sectional boiler of five units, the rear section of which exploded and projected the boiler forward against a wall about 8 feet distant. The fireman was pinned beneath the boiler. The floor above was forced upward about a foot and its supports bent and twisted. A photograph of this accident, reproduced on our cover page, might be termed "before and after." On the right in the picture is shown a five section cast iron hot water heating boiler similar to the one which exploded. On the left is seen the foundation of the exploded boiler.

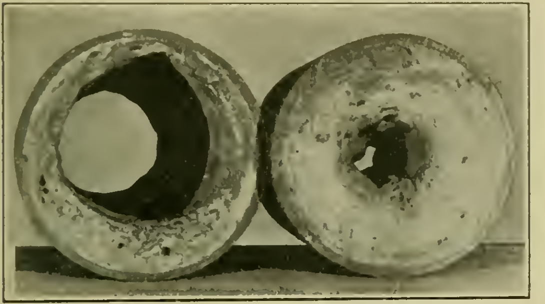
These two boilers were operated on a closed hot water heating system with forced circulation, a centrifugal pump being interposed in the flow line. Available information indicates this accident to be a result of faulty operation. An additional radiator was to be installed in the office building heated by these boilers and, in order not to empty the whole heating system, it was planned to drain it to a level below the point of installation. With this purpose in view, the valve in the flow line and presumably one in the return line were closed. The boilers were thereby closed off without access to any radiating surface. Under such conditions the pressure soon mounted to a dangerous point. There was a one inch relief valve on each boiler but apparently these were not of sufficient capacity, for steam was escaping from one or both of them just prior to the explosion. In fact it was the noise of escaping steam that attracted to the boiler room the man who was injured.

No insurance was carried on this installation.

Droughts and Feed Water.

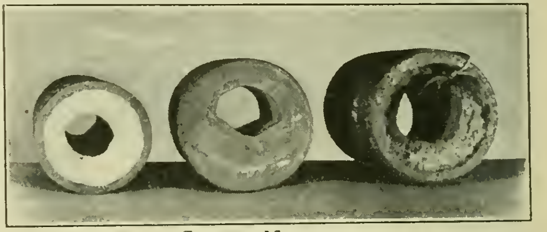
IN the late summer and early fall it is quite usual for certain sections of this country to experience more or less protracted droughts. The rainfall at that time of the year is everywhere at a minimum, a fact that impresses itself in one way or another upon nearly all of us. The boiler plant operator soon feels its reaction upon his feed water supply. At first thought one would probably be inclined to say that the effect upon boiler feed water is merely to diminish the supply. Such a scarcity does, of course, exist, but it acts primarily to aggravate a more insidious fault of the water itself.

All water, as we know, in flowing over or through the ground dissolves a certain amount of mineral salts which make the water "hard" to a greater or lesser degree. These minerals are deposited in the boiler — since nothing but pure water goes off — and supply the scale forming material. The amount of scale and sludge formed in a boiler will depend directly upon the amount of such dissolved substances, or in other words, upon the degree of "hardness" of the water. After using a water from a particular source for some time, there is usually adopted a satisfactory standard of treatment for "softening" and a routine established for the use of the blow-off and for cleaning. Trouble will not be experienced so long as the water remains the same. But that the water supply from a given source does change from time to time, however, is amply shown by experience, particularly during the dry season. Complaints are heard of leaky tube ends, bulged boilers, and other defects usually attributed to scale, and internal inspections and analyses of feed waters confirm the diagnoses. The reason for this natural or seasonal variation in the character of water supplies is well explained in the October 1908 issue of THE LOCOMOTIVE from which we will quote.



BADLY SCALED TUBES.

"The character of a given feed water will often vary to an important degree with the season and with the amount of the rainfall; and a failure to bear this fact in mind often results in serious trouble from scale, and even in the burning of the boilers. This year, for example, the rainfall has been unusually light in many parts of the country, and our inspectors report that there has been an uncommon amount of scale in the regions so affected. The reason for this is not hard to find. The actual supply of water that is used in a boiler consists, almost invariably, of a mixture of surface water and of ground water. That is, some portions of it have probably been down to a considerable depth and have been in contact with lime rocks and magnesia rocks for a considerable time; while other parts have not percolated through the ground very far, or, perhaps, have not been below its surface at all. The degree of "hardness" of a given water (and hence the amount of scale that it will form) will therefore depend to a large extent upon the *proportion* in which the water from the deeper regions of the ground, and that from the surface or from the superficial layers of the soil, are mingled. Now it is evident that this proportion will vary a great deal with the amount of the rainfall; for in a wet season the surface water is especially abundant, and hence the boiler supply is softer than usual; while in a dry season like the present one the superficial layers of the ground are dried out so thoroughly that the supply consists almost entirely of water which has come from the deeper regions, bringing with it a quantity of dissolved mineral matter which tends to make the feed "harder" than usual.



Scaled Nipples
The One On the Right Shows the Result of One Month's Run.

"The lessons to be learned from these very simple considerations are two in number. In the first place, we see that in a dry time the formation of scale is likely to go on more rapidly than usual, so that it is important to open the boilers and clean them (or at least examine them) with a correspondingly greater frequency. It is hard to say just *how much* oftener they should be opened, but it is safe to say that they should be opened at least *twice* as often as usual; a boiler that is ordinarily cleaned once a month being opened up, in a dry time, every fortnight.

"Such is the first lesson, and the second is like unto it. It is almost impossible to keep a boiler *perfectly* free from scale, when using a hard water; and hence it must be expected that a considerable quantity of scale will remain lodged in the boiler, so long as the water remains hard, despite the most conscientious efforts of the attendants to keep it out. When a heavy fall of rain comes, however, so that there is once more an abundance of surface water, the feed water will suddenly become far softer. It will then tend to re-dissolve the scale; and this tendency will manifest itself by loosening up the scale that has accumulated in the boiler and causing it to flake off and fall down upon the fire sheets, causing the sheets to bulge or burn in a short time. It is surprising how quickly a soft feed water will sometimes loosen up old scale in this way. "Snow broth," or the water from melting snow, is peculiarly active in this respect, since it has hardly been in contact with any minerals at all, and is therefore the softest kind of water that is commonly obtainable in any considerable quantity. In the spring, in our northern latitudes, the melting of the snows should therefore be watched carefully; for a boiler carrying any considerable amount of scale should not be allowed, at that time, to go more than a week or two without opening and cleaning; and boilers that are run even with the purest waters should not be left unopened for longer than a month.

"It is common, after an old scale has been peeled off by solvents, or by oil, or after it has flaked off by the use of a water much purer than that from which the scale was originally formed, to be told that the oil, or the solvent, or the purer water, has made the boiler leak. It is true that leakage often does occur under these conditions; but such leakage is not due to any detrimental action of the solvent or other remedial agent. The real damage was done to the boiler by the scale, through over-heating and consequent starting of the joints. While the scale was still lodged upon the tubes and sheets the leaky places had not betrayed themselves, because they were stopped up by the scale; and when the scale is removed, the damage that had been previously done merely manifests itself."

A chemical engineer in one of our large eastern cities, who makes a specialty of keeping power plant boilers clean, stated that during a recent dry spell the city water supply contained 60% more lime and magnesium hardness than usual; and at the same time the city used more alum — this being increased from one part in a million to ten or twelve parts — making the scale extremely hard.

Realizing then the increased scale forming character of water in times of little rainfall, the remedy is obvious. Proper feed water treatment and frequent use of the blow-off will do much toward keeping the boiler clean. The effectiveness of this treatment can best be ascertained by internal inspections. The boiler should therefore be frequently opened for cleaning and inspection.

The small plant which has developed its own source of feed water supply sometimes finds itself "between the devil and the deep sea." Even though the necessity of frequent cleaning is appreciated, the actual shortage of water prevents emptying the boiler too often. Under such circumstances, boiler room records of conditions and treatment during previous droughts are of great assistance.

The following advertisement appeared in a daily paper recently:

> "I worked 39 years making and repairing upholstering and refinishing furniture. I have a few more years to live, why not work me to death?"

An Error of Misplaced Confidence.

By E. Mason Parry,

Chief Inspector, New York Department.

IN this day of "Safety First", it is strange what chances some workmen will take when performing work with which they are supposed to be entirely familiar, and, what is none the less alarming, is the general lack of appreciation of the danger involved in attempting to make repairs on a vessel of any description while the vessel is under pressure. A recent accident which the writer had the opportunity to investigate furnishes a most glaring example.

A tank of the dimensions shown in Fig. 1, formerly used as a container for compressed air and which had seen but very little service, was purchased for installation on the low pressure side of an ammonia refrigeration system of the absorption type. For some reason it was decided to remove the lower 3 inch cast iron nozzle, which was done by means of an oxy-acetylene cutting torch. A hole 10 inches in diameter in the side of the tank resulted, indicated by B in Fig 1 Into this aperture there was inserted, flush with the shell, a piece of steel plate formed to the contour of the vessel and attached to the shell of the tank by the process of electric arc welding. The manhole frame pressed in the top head had also been cut out and into the elliptical opening, 15″ x 20″, there had been inserted, flush with the head, a piece of steel plate fashioned to conform to the radius of the head and electrically welded to same. On completion of this work, the vessel was subjected to an air pressure test of 50 lbs. per square inch and was pronounced tight. The welder then left the premises considering his work finished.

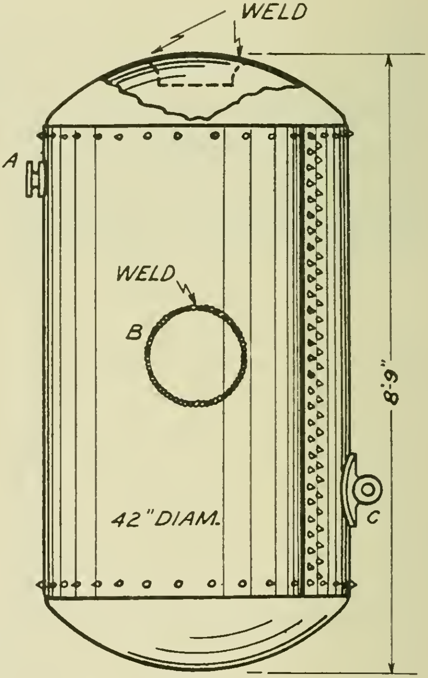


Fig. 1.

A day or two afterwards the plant engineer subjected the tank to a further air pressure test, under which leakage was revealed in the welded area on the top head. On discovering this defect, the matter was referred to the concern that had done the work, which sent the welder back to make the vessel tight. On his arrival at the plant, the tank was subjected to an air pressure test of 100 lbs. per square inch, and by applying soapy water the leaks were located. The welder then proceeded to stop this leakage by caulking the defectively welded area, using a pneumatic caulking tool. Just how long he continued caulking, nobody seems to know. On hearing a loud noise, some of the plant operators started to investigate, and upon entering the part of the building where this tank was located, were horrified to find the unfortunate welder decapitated and lying at the base of the tank. The piece of plate which had been inserted in the top head, having been suddenly and violently blown from its welded fastening, was found lying on the floor.

Examination of the top head showed that no effort had been made to dress the material in order to remove that ever present enemy, oxide, with which welders must contend previous to, and during, welding, as the marks of the cutting torch were plainly seen on the edge of the opening at all points. Furthermore, it revealed that at no point had the welding penetrated to the full depth of the material. In fact, the maximum depth of the welding did not exceed one half of the thickness of the material, and even this condition was found only at scattered points. It was also quite apparent that for nearly one half the distance around the opening hardly any metal at all had been holding. Like beauty, it was only skin deep.

An interesting point brought out in this investigation is the fact that the patch in the shell had been welded from both inside and outside, whereas no provision had been made for welding the patch in the head on the inside. In fact the only openings remaining were the inlet and outlet connections shown at A and C in Fig. 1. These were respectively 3 inches and 2 inches in diameter. It seems unnecessary to point out that even when welded on both sides there is no assurance that the weld is sound.

The result of this investigation clearly sets forth the advisability of refraining from the use of autogenous welding in the fabrication of pressure vessels where the safety of the vessel is dependent on the soundness of the weld. Welding of this description, however, can be satisfactorily resorted to when the parts so treated are relieved of stress and strain by being supported by suitable mechanical means, the welding being used merely to make the vessel tight against leakage. Our Company early realized the danger to which its patrons might be exposed when having repairs made on their pressure vessels by autogenous welding, and to show with what vigilance their interest is protected we printed in bold relief the following request on all our report forms;

"PLEASE CONSULT US BEFORE YOU DECIDE TO HAVE ANY 'WELDING' DONE."

We are pleased to say that on a great many occasions our assured have communicated with us asking our reasons for making this request, and invariably have expressed their appreciation when the matter was fully explained to them. Furthermore, when we have advised against making repairs by the method of welding which is being discussed, it has been our custom to outline the proper way of executing the contemplated repairs. It is to be regretted that more discretion is not used when resorting to autogenous welding in connection with the manufacture of pressure vessels, more especially when it is realized that, for the satisfactory execution of this art, the personal equation is a prominent factor and enters in such a way that there is no way of checking up on it. Regrettable as it is to say, the writer feels sure you will agree with him that in this instance the equation referred to proved to be an unreliable supposition.

In the interest of safety to mankind and as a protection against unnecessary property damage, it is hoped, in fact it is a duty to be fulfilled, that the readers of this article using pressure vessels satisfy themselves that they or their employees are not exposed to an accident similar to that which befell this unfortunate workman. A number of unfired pressure vessels are covered with plastic material, some are also encased in canvas, the application of which is expensive, and many owners, when the information cannot be otherwise obtained, might hesitate to remove a part of this covering to determine how the material of which the vessel is made is held together longitudinally. It is hoped that the warning that can be read between the lines of this article will be fully appreciated, and that no one will hesitate, on account of the small cost involved, to remove a part of the covering to satisfy the apprehension that must be felt after reading this article.

Any "Stray" Bolts In Your Boiler?

In an account of a boiler explosion, one of the conditions existing prior to the accident is set forth as follows: — "Water had been leaking from the boiler through some stray bolts, and during the night must have emptied it."

The First "Hartford" Inspection.

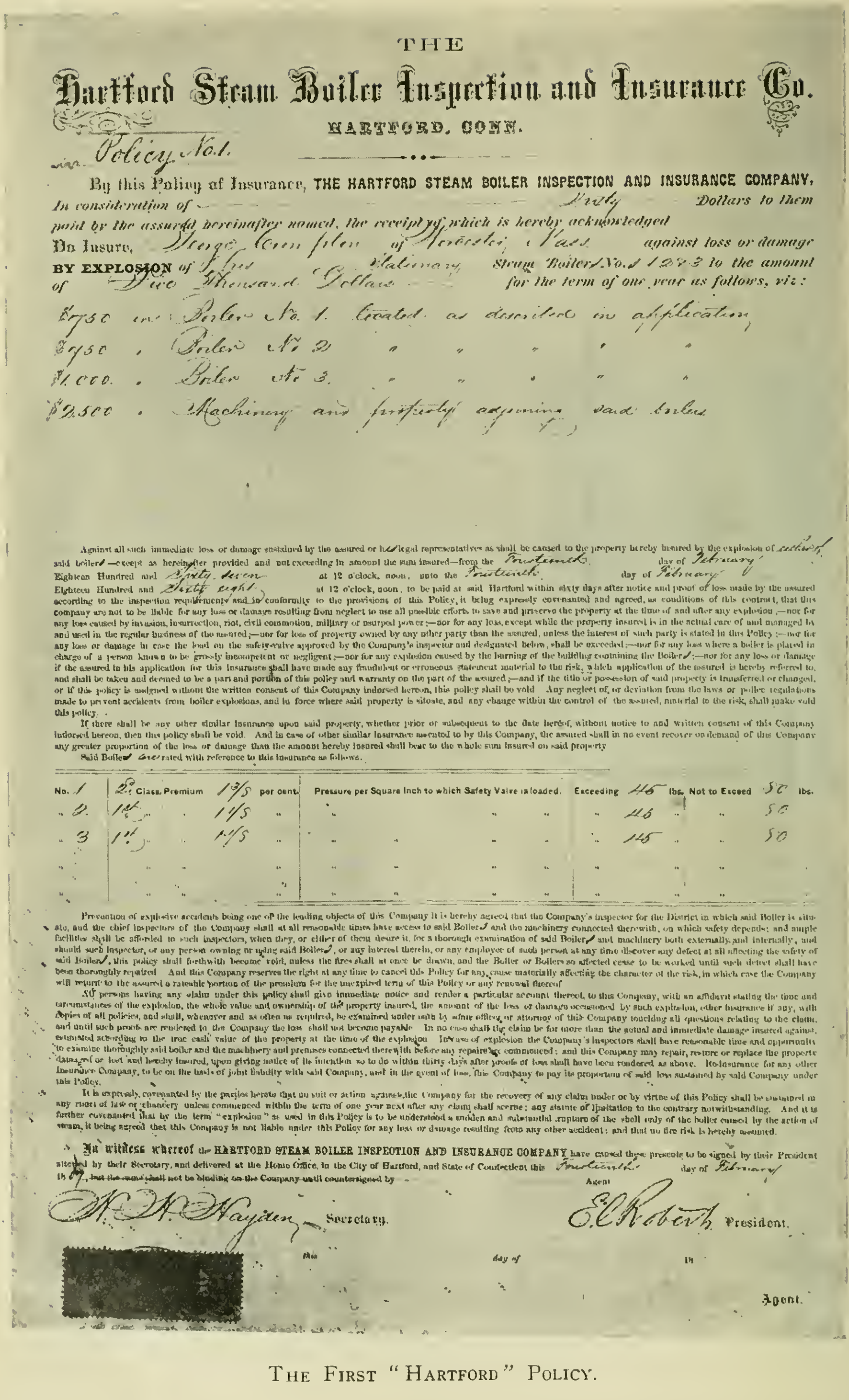
IT was quite by accident, and while running down some other items of interest connected with the early history of this Company, that we recently learned that our first inspection, over 57 years ago, was made by Mr. D. M. Dillon, founder of the Dillon Steam Boiler Works, Fitchburg, Mass. Of nearly a score of New England pioneer boiler makers of about that period, Mr. Dillon is the sole survivor. We were, therefore, able to verify our information at first hand.

D. M. DILLON.

The insurance policy covering the first boilers insured by this Company — which, by the way, were the first insured in this country — was issued February 14th, 1867 and has been framed and on exhibition for some years in the Home Office of the Company at Hartford, but the identity of the inspector who passed upon these boilers had become lost.

This first risk consisted of three horizontal tubular boilers in the plant of the Crompton Loom Works at Worcester, Mass. Since the inspection department had not yet been organized, it was necessary to employ a special inspector for the job. A few of our earliest inspections were made by a man named Gibbs, a machinist, in the employ of the New Haven & Hartford Railroad, and it had been generally thought that he made the first one. It now appears, however, that the work was performed by Mr. Dillon with the assistance of his then business partner, Charles Stewart. Mr. Dillon made the internal and Mr. Stewart the external examinations, spending more than three hours in carefully looking over the boilers. As a result of their report, the boilers were accepted for insurance. It is a great satisfaction to the Hartford Company that it has continuously insured these boilers or their successors for the past fifty-seven years, the present owners being the Crompton & Knowles Loom Works.

It is an interesting coincidence that Mr. Dillon was also interested in the first steel boiler. In fact, he was not only the maker, but also was primarily responsible, through his personal efforts, in having this material given a trial. In 1874 his company received the order for two boilers to be installed in the building for the Mechanics Fair at Boston. The Bay State Iron Works of South Boston, from whom



THE

Hartford Steam Boiler Inspection and Insurance Co.

HARTFORD, CONN.

Policy No. 1.

By this Policy of Insurance, **THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY,** *In consideration of* Sixty *Dollars to them paid by the assured hereinafter named, the receipt of which is hereby acknowledged*

Do Insure, George Crompton of Worcester, Mass. *against loss or damage* **BY EXPLOSION** *of* Three stationary *Steam Boilers No. 1, 2 & 3 to the amount of* Five Thousand Dollars *for the term of one year as follows, viz:*

$750 on Boiler No. 1. located as described in application

$750 " Boiler No. 2 " " " " "

$1,000. " Boiler No. 3. " " " " "

$2,500 " Machinery and property adjoining said boilers

Against all such immediate loss or damage sustained by the assured or his legal representatives as shall be caused to the property hereby insured by the explosion of either of said boilers—except as hereinafter provided and not exceeding in amount the sum insured—from the Fourteenth day of February Eighteen Hundred and Sixty seven at 12 o'clock, noon, unto the Fourteenth day of February Eighteen Hundred and Sixty eight at 12 o'clock, noon, to be paid at said Hartford within sixty days after notice and proof of loss made by the assured according to the inspection requirements and in conformity to the provisions of this Policy, it being expressly covenanted and agreed, as conditions of this contract, that this company are not to be liable for any loss or damage resulting from neglect to use all possible efforts to save and preserve the property at the time of and after any explosion,—nor for any loss caused by invasion, insurrection, riot, civil commotion, military or usurped power;—nor for any loss, except while the property insured is in the actual care of and managed by and used in the regular business of the assured;—nor for loss of property owned by any other party than the assured, unless the interest of such party is stated in this Policy;—nor for any loss or damage in case the load on the safety-valve approved by the Company's inspector and designated below, shall be exceeded;—nor for any loss where a boiler is placed in charge of a person known to be grossly incompetent or negligent;—nor for any explosion caused by the burning of the building containing the Boilers;—nor for any loss or damage if the assured in his application for this insurance shall have made any fraudulent or erroneous statement material to the risk, which application of the assured is hereby referred to, and shall be taken and deemed to be a part and portion of this policy and warranty on the part of the assured;—and if the title or possession of said property is transferred or changed, or if this policy is assigned without the written consent of this Company indorsed hereon, this policy shall be void. Any neglect of, or deviation from the laws or police regulations made to prevent accidents from boiler explosions, and in force where said property is situate, and any change within the control of the assured, material to the risk, shall make void this policy.

If there shall be any other similar insurance upon said property, whether prior or subsequent to the date hereof, without notice to and written consent of this Company indorsed hereon, then this policy shall be void. And in case of other similar insurance assented to by this Company, the assured shall in no event recover on demand of this Company any greater proportion of the loss or damage than the amount hereby insured shall bear to the whole sum insured on said property.

Said Boilers are rated with reference to this insurance as follows.

No.	1	2d Class. Premium	1 3/5	per cent.	Pressure per Square Inch to which Safety Valve is loaded.	Exceeding	45	lbs. Not to Exceed	50	lbs.
"	2.	1st " "	1 1/5	"	"	"	45	" "	50	
"	3	1st " "	1 1/5	"	"	"	45	" "	50	
"		" "		"	"	"		" "		
"		" "		"	"	"		" "		

Prevention of explosive accidents being one of the leading objects of this Company it is hereby agreed that the Company's inspector for the District in which said Boiler is situate, and the chief inspectors of the Company shall at all reasonable times have access to said Boilers and the machinery connected therewith, on which safety depends; and ample facilities shall be afforded to such inspectors, when they, or either of them desire it, for a thorough examination of said Boilers and machinery both externally and internally, and should such inspector, or any person owning or using said Boilers, or any interest therein, or any employee of such person at any time discover any defect at all affecting the safety of said Boilers, this policy shall forthwith become void, unless the fires shall at once be drawn, and the Boiler or Boilers so affected cease to be worked until such defect shall have been thoroughly repaired. And this Company reserves the right at any time to cancel this Policy for any cause materially affecting the character of the risk, in which case the Company will return to the assured a rateable portion of the premium for the unexpired term of this Policy or any renewal thereof.

All persons having any claim under this policy shall give immediate notice and render a particular account thereof, to this Company, with an affidavit stating the time and circumstances of the explosion, the whole value and ownership of the property insured, the amount of the loss or damage occasioned by such explosion, other insurance if any, with copies of all policies, and shall, whenever and as often as required, be examined under oath by some officer or attorney of this Company touching all questions relating to the claim, and until such proofs are rendered to the Company the loss shall not become payable. In no case shall the claim be for more than the actual and immediate damage insured against, estimated according to the true cash value of the property at the time of the explosion. In case of explosion the Company's inspectors shall have reasonable time and opportunity to examine thoroughly said boiler and the machinery and premises connected therewith before any repairs are commenced; and this Company may repair, restore or replace the property damaged or lost and hereby insured, upon giving notice of its intention so to do within thirty days after proofs of loss shall have been rendered as above. Re-Insurance for any other Insurance Company, to be on the basis of joint liability with said Company, and in the event of loss, this Company to pay its proportion of said loss sustained by said Company under this Policy.

It is expressly covenanted by the parties hereto that no suit or action against the Company for the recovery of any claim under or by virtue of this Policy shall be sustained in any court of law or chancery unless commenced within the term of one year next after any claim shall accrue; any statute of limitation to the contrary notwithstanding. And it is further covenanted that by the term "explosion" as used in this Policy is to be understood a sudden and substantial rupture of the shell only of the boiler caused by the action of steam, it being agreed that this Company is not liable under this Policy for any loss or damage resulting from any other accident; and that no fire risk is hereby assumed.

In witness whereof the **HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY** have caused these presents to be signed by their President attested by their Secretary, and delivered at the Home Office, in the City of Hartford, and State of Connecticut this Fourteenth day of February 1867, ~~but the same shall not be binding on the Company until countersigned by~~ Agent

H. H. Hayden Secretary.

E. C. Roberts President.

this day of 18

Agent.

THE FIRST "HARTFORD" POLICY.

the Dillon Company bought its boiler plate, had been experimenting with the manufacture of steel and had installed a large open-hearth furnace. It then became necessary to develop a demand for the product, which they called "homogeneous metal", and so turned to the field of boiler plate. They furnished samples of the new material to Mr. Dillon and endeavored to persuade him to substitute it for the usual wrought iron. Cast steel had been used to some extent in furnaces but not very successfully, trouble being experienced from cracking. Not very enthusiastic over the prospects, Mr. Dillon, nevertheless, had the samples subjected to the usual physical tests at the Massachusetts Institute of Technology. The results were very gratifying, the tensile strength, in fact, being unusually high. In order to further test its suitability, a sample was heated by Mr. Dillon in a forge and quenched with water. Instead of becoming brittle, it was found very ductile. This discovery aroused Mr. Dillon's enthusiasm and he immediately set about securing permission to use open-hearth steel in the boilers for the Mechanics Fair. Permission was reluctantly given, but later, after the boilers had been completed and were about to be installed, was withdrawn. The reason given was that they were not safe. All objections, however, were finally overcome — partly, no doubt, by Mr. Dillon's offer to personally sit on top of one of the boilers throughout the Fair — and the steel boilers installed.

An interesting sidelight in connection with the manufacture of these boilers is the fact that, although Mr. Dillon was utilizing steel primarily in the interests of the plate makers, yet they refused to roll the plates in the manner he desired. It was desired to make the boilers with a single sheet for each course, but plates of sufficient length could not be obtained until Mr. Dillon offered to stand the cost of rolling two experimental plates should they be spoiled in the process. These first steel boilers were, therefore, built with but one horizontal seam in each ring. They were inspected and accepted for insurance by this Company.

Further evidence of Mr. Dillon's progressiveness as a boiler maker is shown by the fact that he was an early advocate of the use, in stationary practice, of "pop" safety valves as well as in the elimination of steam domes.

In a contemporary technical magazine appeared the head line "Water-Cooled Furnaces Make Records at Hell Gate." Cheerful news to some of us.

Safety Valves and Birds' Nests.

By Robert P. Guy,
Assistant Chief Inspector, New York Department.

IT would naturally be supposed that when a man had reached the age necessary to have acquired sufficient knowledge and experience to enable him to qualify as a boiler inspector, the pleasures of boyhood days would be but memories of the dim past, never again to be revived. The exception which proves the rule, however, is forcibly illustrated by the following incident which occurred in the writer's experience about six years ago when making an external inspection of four horizontal tubular boilers.

On arrival at the plant, the Inspector paid his customary social call at the office, where he was well acquainted, chatted for a few moments with the Chief Engineer in the engine room, and then proceeded to make the usual external inspection. He watched the Fireman blow down the water column and operate the try cocks, and then asked to have the safety valves blown. The boilers were each equipped with one 4 inch pop type valve, the escape pipes being carried horizontally through the building wall and discharging outside. The Fireman went up the ladder to blow the valves and the Inspector went outside to observe the discharge from the escape pipes. The valve on boiler No. 1 was first blown and everything was satisfactory. When No. 2 was blown it was noted that something in the form of solid matter was ejected from the pipe and, striking a wall about 6 feet distant, fell to the ground. An examination of this object showed it to be a bird s nest battered out of shape and containing some eggs which had been smashed. The Inspector was somewhat alarmed at this discovery for, while he realized that it was indeed the season of the year when as a boy he hunted birds' nests, he remembered that they were usually found in hedges and trees and in some cases in the grass, but never had he found or heard of one being found in a piece of iron pipe; especially a pipe that at one end was connected to a boiler carrying 140 lbs. steam pressure.

The valve on boiler No. 3 was next blown and another bird's nest was ejected. This one, like the first, was battered out of shape by the impact against the wall. Unlike the other, however, it contained no eggs but instead there were three fledglings which had just been hatched out and which, of course, had been scalded to death by the escaping steam. The valve on boiler No. 4 was next blown and, like No. 1, was found free and clear of obstructions.

The Inspector again sought the Chief Engineer and asked him how often the valves were blown. He replied, "Every morning, regularly." Asked if he personally saw them blown, he stated that he did not but he stood in the engine room and heard them blown one after another each morning. The subject was changed by the Inspector and the fine weather being experienced just then was commented on, the Inspector intimating that it must be about time for the birds to be building their nests. He then asked the Chief about how long it would take a bird to build its nest and hatch out the eggs. The Chief replied that he was not very well posted in such matters but presumed that it would take several weeks. He was then invited outside and shown the nests, and, on being informed where they came from, expressed surprise and indignation. Inquiry of the Fireman brought forth the assertion that all valves were blown every day, but, on being confronted with the evidence of failure to blow Nos. 2 and 3, he admitted his neglect. When the time arrived each morning to try the valves, he blew the valve on one boiler only, blowing it four times and allowing a liberal interval between blows to give the impression that all four had been blown. This practice was alternated weekly between boilers Nos. 1 and 4. The reason assigned for not blowing boilers Nos. 2 and 3 was that there were too many pipes to climb between to reach them. After explaining the seriousness of this practice, the Inspector left with an assurance that the valves would be properly blown in the future.

About three months afterwards the Inspector again visited this plant for the purpose of inspecting one of the boilers internally. On entering the combustion chamber, he observed a bundle of straw in one corner which, on investigation, was found to be a creditable imitation of a bird's nest on a large scale and containing one dozen fresh hen fruit just off the farm. Fearing that, should someone neglect to remove them before the boiler was fired up, they might, if not hatched out, be somewhat overcooked, the Inspector transferred them to his grip and later found that, with a few rashers of bacon, they made excellent breakfast food.

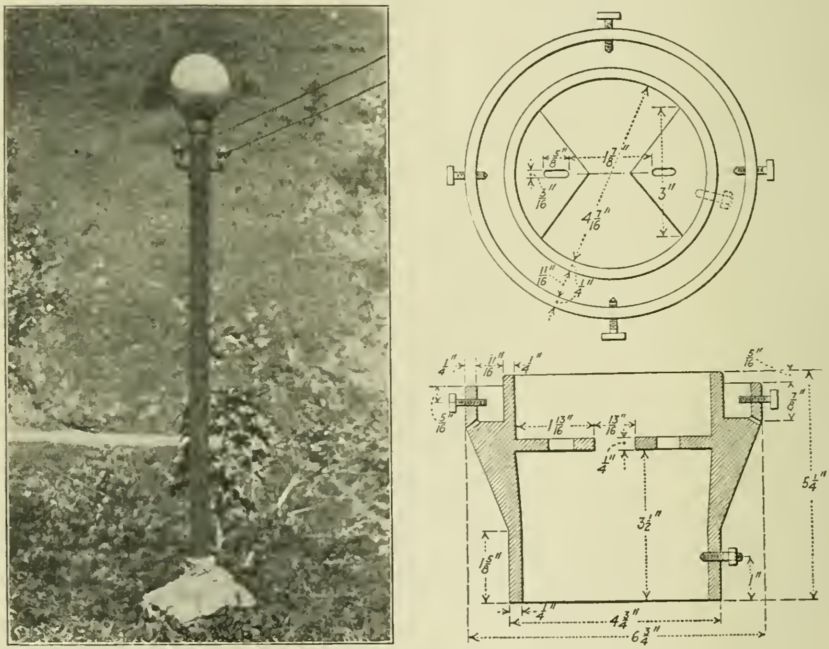
A Limited Interest.

"When you found you hadn't your fare, did the conductor make you get off and walk?" asked the inquisitive man.

"Only get off," was the sad reply, "He didn't seem to care whether I walked or sat down."—*New York Central Lines Magazine.*

Old Boiler Tubes Used for Lighting Posts.

A VERY simple yet decorative lighting post made up from old boiler tubes is used around all the plants and substations of the Porto Rico Railway, Light & Power Company. This company annually discards from its steam plant many 4-in. boiler tubes which, while no longer of value in a boiler, are useful for a variety of other purposes. A great many have been used for ornamental light posts, and for this purpose castings were made up as shown in the drawing. The castings were designed to fit the standard 6-in. x 12-in. "Alba" opal globe.



Lighting Post Made From An Old Boiler Tube, and Casting Adapting It to a Standard Globe.

Some of these posts were wired with underground cable, but in most cases a small stone and concrete base was built around them to give added stability and the wires were carried on iron brackets, as shown in the accompanying illustration. — *Frederick Krug in the "Electrical World," Dec. 1, 1923.*

Repairing Vessels While Under Pressure.

THE exceedingly dangerous practice of repairing boilers, pipe lines, and various pressure vessels while they are under pressure appears to be so generally followed that one is led to believe that the danger is not really appreciated. But knowing the inherent gambling instinct in man and how ready he is to take the "short cut," that Nemesis of safety, it ought not be difficult to admit that the prevalence of this practice is partly due to thoughtlessness or carelessness. To instruct the man who is willing to learn, and to continually admonish the thoughtless, this Company from time to time points out some of the unfortunate results of such bad practice which come to its attention. In making up the explosion list for the month of September of last year, there came to our attention no less than four clippings of accidents which it would appear resulted from attempts to repair steam containers while under pressure. We are reprinting five such clippings.

Walter Sexton Scalded By Exploding Boiler.

Mr. Walter Sexton was badly scalded Monday about noon by the explosion of a boiler at the General Ice Company plant, on Deery Street. He was fixing to take the end out of the boiler to repair it when an explosion occurred, caused by the water running low in the boiler, and blew out the manhead, throwing hot water and steam on his left arm, shoulders and back, badly blistering the flesh. His injuries, though painful in the extreme, were not thought to be dangerous.— *Shelbyville Tennessee Times, Aug. 31, 1923.*

[This appears to be a case of opening a warm boiler before it is entirely empty.— Ed.]

Accident May Cost Sight Of Dairyman.

Physicians were fighting Saturday morning to save the eyesight of Walter Bowie, 40, 997 Jefferson Avenue, who was badly burned at 7:45 A. M. Saturday, by escaping steam.

Bowie, an employe of Reed Brothers' Dairy, 147 N. Pauline Street, was attempting to put a wheel on a steam valve when the pressure in the boiler blew open the valve and a column of steam struck him in the face.

A. L. Reed, one of the owners of the dairy, rushed Bowie to the Baptist hospital.

Bowie's eyes were seared by the steam, but physicians hope to save his sight.— *The Memphis Press, September 8, 1923.*

Two Burned In Boiler Accident At Modesto.

Modesto, Sept. 10th:— A. H. Pierce of Ripon, assistant foreman of the Sun Garden Canning Company, who was seriously burned about the head and body Saturday night when a boiler exploded, was declared out of danger at the Robertson Hospital here today. Oscar Studley was also badly burned. They were repairing the boiler when an expansion joint became loose. A burst of steam knocked Pierce off the boiler. The joint was tightened and no damage to the cannery occurred.— *San Francisco Chronicle, September 11, 1923.*

Boilermaker Is Badly Scalded.

C. P. Newby, a boilermaker working at the Missouri Pacific shops in Baring Cross and living at 2720 West Sixth Street, Little Rock, was slightly scalded about the right shoulder and right side of the face while at work in the boiler shop at the shops about 3 o'clock Sunday afternoon when a steam pipe on a locomotive burst and threw the boiling water over him.

He was taken to the emergency hospital at the shops where his injuries were dressed and then removed to his home. According to a statement he made to the attending doctor he was knocking rust out of a boiler pipe on the locomotive when a steam pipe burst and the scalding water flooded the boiler. It was reported at the shops Monday morning that he was only slightly hurt and would be able to return to his work in a few days.— *Arkansas Democrat, September 23, 1923.*

Locomotive Engineer Dies From Injuries.

Little Rock, Ark., Sept. 25th:— H. L. Hickman, Rock Island engineer, died last night as the result of injuries suffered yesterday morning when he, with Fireman W. E. Oden, was terribly scalded by a mixture of steam, boiling water and fuel oil. Oden's condition is said to be serious.

The fatal accident, it is reported, was caused by a leak in the crown sheet of an engine the men were repairing, which allowed the scalding water and vapor to gush upon them.— *Memphis News Scimitar, September 25, 1923.*

An old darky got up one night at a revival meeting and said: "Brudders an' sisters, you knows an' I knows dat I ain't been what I oughter been. Ise robbed hen-roosts and stole hawgs, an' lies, an' got drunk, an' slashed folks wi' mah razor, an' shot craps, an' cussed, an' swor: but I thank the Lord der's one thing I ain't nebber done: I ain't nebber lost mah religion."— *Western Christian Advocate.*

Is Your Boiler Inspected?

THE following description of a boiler explosion which occurred recently is given for the benefit of every person who is the owner of any vessel carrying steam under pressure.

Two brothers, who were owners and operators of a boiler used to supply power to drive a saw mill, feed mill, and cider mill, were engaged at work when the boiler exploded. The boiler was of the locomotive fire box type, mounted on wheels; and had evidently been in bad condition for some time.

The explosion blew the boiler through the roof and it struck the ground about 300 feet to the right with such momentum that it leaped 50 feet, landing on the right side 350 feet from the original position. The boiler was completely stripped of all appliances.

A cutomer of the owners was driving toward the lean-to in which the boiler was housed, arriving a few minutes after the explosion. However, the noise frightened his horses so that they ran away, but they carried him away from the danger of flying particles.

One of the brothers was killed.

An inspection made shortly after the explosion failed to show a steam gauge or a safety valve, and showed that the blow-off pipe was blocked.

If the owners had had this boiler regularly inspected, no doubt, both of these men would be living today. No boiler inspector would have approved this boiler for operating purposes in the condition in which it was found. It was very fortunate that the customer who was driving up at the time of the explosion was not injured. If he had been, he could have, without doubt, recovered heavy damages from the owners as they had not taken proper precautions against danger or prosecution by having the boiler inspected at least once a year internally, while not under working pressure, and once a year externally while under working pressure.

This boiler explosion points out the danger to the owner of any establishment who fails to have boilers inspected in accordance with the law. In the event of an explosion and injury to outsiders, he could very likely be prosecuted for criminal negligence; and he is also endangering his own life by such neglect.

Every boiler must be inspected internally by an approved boiler inspector each year. A certificate of inspection is issued by the Department of Labor and Industry giving the date of the last inspection. This certificate should be displayed conspicuously in the boiler room or upon the boiler. If this is done, the owner is complying with the provisions of the law and is thereby protecting himself, his employees and the public as fully as it is possible to protect them against an ever present hazard. Every boiler must be placed in charge of an experienced operator who understands operating requirements thoroughly.— *Labor and Industry, Commonwealth of Pennsylvania.*

Pittsburgh's Giant Boiler.

A MAMMOTH boiler, thought to be the largest boiler in the world, has just recently been put into operation in the Cecil Plant of the Allegheny County Steam Heating Company, Pittsburgh, Pa. It is a water tube boiler of the cross drum type. Some idea of its huge proportions may be obtained from a consideration of its principal dimensions. The drum, for instance, is 60 inches in diameter by 34 ft. long. There are 1173 tubes each 24 ft. long which, together with wall cooling tubes, gives approximately six miles of 4 inch tubing. The heating surface amounts to 32,750 sq. ft. Based on the heating surface, the boiler is nominally rated at 3,000 horse-power, but it is capable of operating continuously at 300% of the rated capacity. The maximum rate of evaporation is approximately 200 tons per hour or about 400% of rating.

The shell is of 11/16 inch plate, triple riveted butt seam construction, being designed for 190 lbs. working pressure. The heads are of ⅞ inch plate.

The furnace is of special construction, having cooling tubes located in the side and rear walls and over the ash hoppers. The furnace is designed to burn pulverized coal, and the furnace volume above the water screen is 19,350 cu. ft. The equivalent grate area is 550 sq. ft., and area of uptake 140 sq. ft.

Steam will be taken off from this boiler through two 10-inch nozzles. Feed water connections are 6 inches in diameter. There are seven safety valve connections, each supplied with two 4½ inch valves, making a total of fourteen 4½ inch safety valves.

This boiler is the first of four similar units which are to constitute this plant when completed. As its name implies, the company operates as a central station steam heating plant. Steam is generated at 150 lbs. pressure, although the boiler is designed for 190 lbs., and distributed at a pressure of from 3 to 5 lbs. for heating and process work. The total cost of the plant will exceed $2,000,000 and will replace three existing plants.

Caught in the Separator.

"The wisest men that e'er you ken
Have never deemed it treason,
To rest a bit, and jest a bit,
And balance up their reason;
To laugh a bit, and chaff a bit,
And joke a bit in season."

From an old calendar.
—*Research Narratives.*

12 CRAP SHOOTERS BURNED BY HOT PIPE AS THEY DODGE GUN.

Steubenville, O., July 18.— (A. P.) — Twelve of thirteen Negro laborers who participated in a dice game at the La Belle Iron Works labor camp here today are in the mill hospital, suffering from burns.

The ivory gallopers were being tossed on a long table, the man having the dice being on the opposite side of the table from the other twelve.

One of the twelve reached for the rich " pot " of money in the center of the table. The man opposite reached for a gun.

As it flashed, twelve men ducked, and all squatted on a red hot steam pipe. Twelve pairs of trousers were ruined and the owners won't sit down to meals for some days.— *The Gazette Times, Pittsburgh, Pa., July 19, 1923.*

IDENTIFYING A FORD.

Joe Haas tells about a tin roof of a Kansas store that was torn off and rolled into a compact bundle by a cyclone. Having a sense of humor, the owner wrapped a few strands of bailing wire around the ruin and shipped it to Henry Ford. In due time came a communication saying:

" It will cost you $48.50 to have your car repaired. For heaven's sake, tell us what hit you! " —*Selected.*

JUST MAKE IT A ROUND TRIP.

An old colored mammy was holding up the line in front of the ticket seller's window. " I want a ticket for Florence," she was saying.

The ticket agent, after a great deal of fumbling over railroad guides, asked: " Where is Florence? "

The old mammy replied: " There she is, settin' over dar on de bench." — *Powerfax.*

The Locomotive

DEVOTED TO POWER PLANT PROTECTION
PUBLISHED QUARTERLY

WM. D. HALSEY, Editor. B. C. CRUICKSHANKS, Assistant Editor.

HARTFORD, CONN., OCTOBER, 1924.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

FOREWARNED is forearmed. Problems must be solved daily as part of the routine of the power plant operative. Some of these problems will arise but once; some will arise infrequently; still others will be repetitive. Some can be solved permanently, once for all time. Others are the result of varying conditions, and their recurrence must be continually guarded against. Among the latter is the problem of feed water treatment. Variation in the character of feed water is usually only detected by chemical analysis. Occasionally, however, a physical indication is given which may enable us to be forearmed if we are able to read the signs. The prevalence of a drought is one signal that should be heeded whether or not it results in an actual shortage of water. The reasons are set forth in the article on page 98 of this issue.

In a special article we have endeavored to point out, by citing particular cases, the inadvisability of working on pressure vessels while they are under pressure. The accident described on page 102, though cited because of the lesson it contains on autogenous welding, should also be mentioned in this connection, as the "last straw" was undoubtedly the stress due to caulking.

Personal

WE are pleased to announce the appointment of Mr. Poyntz M. Murray as Manager of our Chicago Department to succeed the late Mr. James F. Criswell.

Mr. Murray came to this Company in December 1912 as a Special Agent in the Atlanta Department, where he developed his ability in the adjustment of claims. Accordingly, in November, 1917, he was transferred to the Chicago Office as Adjuster and Special Agent, and in October, 1918, was made Assistant Manager. During the illness of Mr. Criswell, late Manager of the Department, his responsibilities were greatly increased and so well borne that, at Mr. Criswell's death, he was appointed Manager.

Obituary.

William J. Farran.

On Sunday, July 27th, 1924, Mr. William J. Farran, the then earliest employee in the service of the Hartford Steam Boiler Inspection & Insurance Company, died at his home in Jenkintown, Pa., in his 81st year.

Mr. Farran was born in Philadelphia, February 5th, 1844. Educated in the public schools of that city, he later learned the trade of boiler maker. On December 31st, 1869, when this Company was less than three years old, Mr. Farran joined the organization as Inspector in the Philadelphia Department, becoming Chief Inspector in 1891. In 1915 he gave up active work as Chief Inspector, but remained with the Company in an advisory capacity until his death.

The inspection branch of this Company is essentially a department of service, and in it Mr. Farran ably performed a labor of love. His sterling character and devoted loyalty to this Company contributed greatly toward establishing, in the early days, the prestige which the Company now enjoys. It is with a sincere feeling of regret that we mark the end of his splendid career.

William J. Farran.

George L. Shepley.

Sunday, August 3rd, 1924, marked the passing of Mr. George L. Shepley of Providence, R. I., for more than thirty years representative of this Company in Rhode Island.

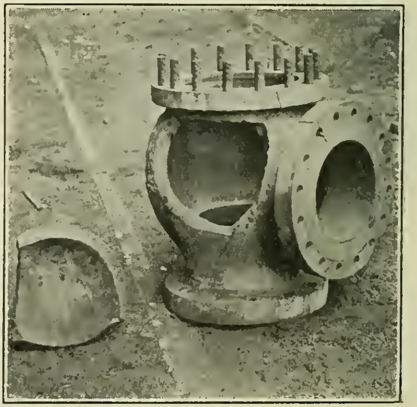
Mr. Shepley was keenly interested in literature and art, but his various civic, industrial and financial activities made him well known in his chosen field of insurance. As President of the firm of Starkweather & Shepley, Inc., he was one of the most prominent insurance men in this country

Mr. Shepley had been in poor health for nearly two years, and his death, although not unexpected, comes as a real loss to the community as well as to his many friends and relatives.

Elbert A. Corbin.

Mr. E. A. Corbin, for more than thirty-five years representative of this Company in Philadelphia, died suddenly at his home in that city, Sunday, August 17, 1924.

Mr. Corbin was senior member of the firm of Corbin & Goodrich, later Corbin, Goodrich & Wickham. He retired from business in 1914, but remained in robust health until almost the day of his death. In fact, having occasion to stop at the office just three or four days previous, he was complimented upon his appearance and activity for a man over 80 years of age. His sudden death was, therefore, a shock to his manv friends.



An illustration of the damage done by water hammer. In the plant where this accident happened, the fires had been banked for over the week-end, but on Sunday morning there was a sudden call for steam. The boilers were rapidly forced to meet the demand and, while doing this, water hammer developed in the main steam header. Three successive blows were delivered upon one of the stop valves which finally gave way as shown in the illustration. Fortunately, no one was injured by the accident. It was said the boiler on which the accident occurred was carrying a high water level and that the engineer was blowing down to overcome this when the rupture took place.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF OCTOBER 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
560	10	Section of heating boiler cracked			University of Pittsburg	University	Pittsburgh, Pa.
561		Boiler bulged and ruptured			Central States Gas Co.	Gas Plant	Vincennes, Ind.
562		Air tank exploded		1	Columbia University	University	New York, N. Y.
563	11	Section of heating boiler cracked			R. F. & P. R. R. Co.	Union Station	Alexandria, Va.
564		Boiler exploded	3		S. S. Daghild	Steamship	Delaware River.
565	12	Accident to steam main fittings			Smith-Lohr Coal Mining Co.	Coal Mine	Pana, Ill.
566		Crown sheet of locomotive failed	2		New York Central R. R. Co.	Repair Shop	Collinwood, Ohio.
567		Boiler ruptured			Howard Gin Co.	Cotton Gin	Howard, Tex.
568		Boiler ruptured		2	Carnegie Steel Co.	Steel Plant	Farrell, Pa.
569		Automatic stop valve ruptured			Cluett, Peabody & Co., Inc.	Bleachery	Waterford, N. Y.
570	13	Two sections heating boiler cracked			The Windle Company	Hotel	Jacksonville, Fla.
571		Tube ruptured			Calif. Packing Corpn.	Cannery	Los Angeles, Calif.
572		Flue plug of locomotive blew out	1	1	M-K-T R. R. Co.	Railroad	Smithville, Tex.
573		Six sections heating boiler cracked			Phillips University	University	Enid, Okla.
574		Three sections heating boiler cracked			Estate of Jacob Wertheir	Miscellaneous	New York, N. Y.
575	14	Boiler bulged and ruptured			G. A. Hoagland Company	Candy Factory	Omaha, Neb.
576	15	Two sections heating boiler cracked			Highland Park Public Schools	School	Highland Park, Mich.
577	16	Main stop valve ruptured			Security Flour Mills	Flour Mill	Abilene, Kan.
578	17	Hot water heater exploded			First Baptist Church	Church	Medina, Ohio
579	18	Section of heating boiler cracked			Goodbinder Bros.	Stores	Omaha, Neb.
580	19	Drying cylinder exploded		4	Columbus Union Oilcloth Co.	Oilcloth Factory	Columbus, Ohio
581	20	Section of heating boiler cracked			Aaron Lertzman	Dept. Store	Lorain, O.
582		Superheater safety hand-hole cap blew off			Central Illinois Light Co.	Power Plant	Peoria, Ill.
583		Three sections heating boiler cracked			R. L. Edmonston	Hotel	E. Liverpool, O.
584		Boiler bulged and ruptured			Geo. Brown's Sons	Cotton Mill	Lenni, Pa.
585		Three sections of heating boiler cracked			D., P. & E. Smolinsky	Theatre	Kansas City, Mo.
586		Boiler bulged and ruptured			De Soto Creamery & Produce Co.	Cold Storage Plant	Minneapolis, Minn.

MONTH OF OCTOBER 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
587	20	Section of heating boiler cracked			I. Press & Sons	Store & Office Bldg.	Phila., Pa.
588	22	Section of heating boiler cracked			Board of Education	School	Bridgeport, Conn.
589		Mud drum ruptured			Armour & Co.	Packing House	Sioux City, Ia.
590		Three tubes ruptured			Armour & Co.	Packing House	Sioux City, Ia.
591	23	Header cracked		1	Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.
592		Accident to ammonia receiver	1	1	Borden Farm Products Co.		Brooklyn, N. Y.
593		Tube pulled out of drum			Armour & Co.	Packing House	Sioux City, Ia.
594		Three sections of heating boiler cracked			Cons. Amusement Enterprises	Theatre	New York, N. Y.
565		Three headers cracked			Lange Floral & Nursery Co.	Florist	Dallas, Texas
596		Five sections heating boiler cracked			Lippman Schnurmacher	Garage	New York, N. Y.
597		Section of heating boiler cracked			Ramsay Realty Corpn.	Apartment House	New York, N. Y.
598		Tube ruptured	1	11	Weirton Steel Co.	Steel Plant	Weirton, W. Va.
599	24	Tube ruptured		2	Fisher Body Corpn.	Auto Bodies	Detroit, Mich.
600		Hot water heater exploded		1	120 Riverside Drive	Apartment House	New York, N. Y.
601		Boiler exploded			Philip Hiltner Farm	Oil Well	Delphos, Ohio
602		Manifold of heating boiler cracked			St. Elizabeth Industrial School	School	New York, N. Y.
603		Section of heating boiler cracked			Helen V. Ryan	Mercantile Bldg.	Bridgeport, Conn.
604		Boiler ruptured	2	1	Southern Lumber & Timber Co.	Lumber Mill	Orvisburg, Miss.
605		Crown sheet of locomotive failed			Turner-Farber-Love Co.	Saw Mill	Tchula, Miss.
606		Two sections heating boiler cracked			W. A. Davis	Saloon	Syracuse, N. Y.
607	25	Section of heating boiler cracked			Carolina Apartments Co.	Apartment House	Wilmington, N. C.
608		Twelve sections heating boiler cracked			City of Troy	School	Troy, N. Y.
609	26	Four sections heating boiler cracked			H. P. Hood & Sons, Inc.	Dairy Products	Charlestown, Mass.
610		Non-return valve failed	2	10	Allegheny Steel Co.	Steel Plant	Harrison Twp., Pa.
611	27	Boiler exploded			Hartley Gin Co.	Cotton Gin	Greenville, Ala.
612		Three sections of heating boiler cracked			St. Thomas' Church	Church	Memphis, Tenn.
613		Two sections heating boiler cracked			Hale Bros., Inc.	Store, Hotel and Theatre	San Francisco, Calif.
614	28	Section of heating boiler cracked		1	Bishop of Belleville	Church	Mt. Carmel, Ill.
615	29	Tube ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
616		Jacketed kettle collapsed			Libby, McNeil & Libby	Packing House	Chicago, Ill.
617		Three headers cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
618	30	Tube ruptured			Bastrop Paper & Pulp Co.	Paper Mill	Bastrop, La.

619		Two headers of heating boiler cracked			Board of Education	School	Hiawatha, Kan.
620		Crown sheet of boiler failed	1		Ragged Point Well	Oil Well	Melrose, Mont.
621	31	Twenty-one sections heating boiler cracked			City of Jackson	School	Jackson, Tenn.
622		Tube ruptured			Armour & Co.	Packing House	Sioux City, Ia.
623		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.

MONTH OF NOVEMBER, 1923.

624	1	Header fractured			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
625		Section of heating boiler cracked			Church of the Immaculate Heart	Church and School	Chester, Pa.
626		Two sections heating boiler cracked			Ninth Ward Realty Co.	Miscellaneous	New York, N. Y.
627		Section of heating boiler cracked			Standard Screw Products Co.	Screw Products	Detroit, Mich.
628	2	Eight sections heating boiler cracked			Auto Selling & Supply Co.	Garage	N. Bedford, Mass.
629		Boiler exploded			National Pure Milk Co.	Milk Station	Dresden, Tenn.
630		Hand-hole cover blew off			Central Ice & Cold Storage Co.	Cotton Gin	Dallas, Tex.
631		Water column connection failed			Gordon Lewis	School	Jarrell, Tex.
632	3	Five sections heating boiler cracked		1	School Dist. No. 46	Refrigeration Plt.	Sedgwick, Colo.
633		Boiler bulged and ruptured			Seattle Box Co.	Box Factory	Seattle, Wash.
634	5	Two sections heating boiler cracked			Louisville Cotton Mills Co.	Cotton Mill	Louisville, Ky.
635		Three sections heating boiler cracked			Thomas A. Galt Estate	Hotel	Sterling, Ill.
636		Fitting in blow-off line failed			American Furniture Co.	Furniture Factory	Martinsville, Va.
637		Tubes pulled out			Pacific Spruce Corpn.	Lumber Mill	Toledo, Ore.
638	6	Ammonia coil pipe ruptured			Crystal Ice & Cold Storage Co.	Refrigeration Plt.	Montgomery, Ala.
639		Oxygen tank exploded			State Mineral Springs Reservation	Auto Repair Shop	Saratoga Springs, N. Y.
640		Boiler exploded			Universal Furniture Co.	Storeroom and Residence	Chicago, Ill.
641		Tube ruptured	1		Louisville Rwy. Co.	Power Plant	Louisville, Ky.
642	8	Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
643	9	Steam dome blew off		2	Simms Oil Company	Oil Well	Corsicana, Tex.
644		Air tank exploded		1	C., St. P., M. & O. R. R. Co.	Repair Shop	Sioux City, Ia.
645		Feed water heater exploded	2	2	Ohio Match Co	Match Factory	Wadsworth, O.
646		Blow-off pipe pulled out		1	San Antonio Oil Works	Cotton Gin	Stockdale, Tex.
647		Section of heating boiler cracked			D. Berg & P. Publicker	Office Bldg. and Theatre	Philadelphia, Pa.
648		Four sections of heating boiler cracked			J. B. Nall & L. M. Neas	Office Bldg.	Kinsport, Tenn.
649	10	Section of heating boiler cracked			Beard & Duloney	Hospital	Dyersburg, Tenn.
650		Section of heating boiler cracked			Lydia H. Roper Home	Apartment House	Norfolk, Va.

MONTH OF NOVEMBER, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
651	10	Section of heating boiler cracked			Hampden Garage	Garage	Holyoke, Mass.
652		Section of heating boiler cracked			City of Revere	Fire Station	Revere, Mass.
653	12	Boiler exploded	2		William Huckvale	Green House	Chatham, N. J.
654		Headers cracked			Kingan & Co., Inc.	Packing House	Philadelphia, Pa.
655	13	Header cracked			Eastman Kodak Co.	Photo Supplies	Rochester, N. Y.
656		Two sections heating boiler cracked			Buchanan & Bolt Wire Co.	Wire Works	Holyoke, Mass.
657		Two sections heating boiler cracked			Hyman G. Ellis	Store	Watertown, N. Y.
658	14	Tube ruptured			Scoville Mfg. Co.	Manufacturing	Waterbury, Conn.
659		Boiler exploded			St. Joseph's Catholic Home	Orphanage	Wilmington, Del.
660		Five sections of heating boiler cracked			Universal Service Motors Co.	Garage	Philadelphia, Pa.
661	15	Boiler of locomotive exploded	1	2	Atchison, Topeka & Santa Fe Rwy.	Railroad	Valley View, Tex.
662		Two sections heating boiler cracked			W. H. Kildow	Cigar Factory	Tiffin, Ohio
663		Five sections of heating boiler cracked			Washington School	School	Norman, Okla.
664	16	Pressing machine exploded		2	Joy Pressing Shop	Clothes Pressing Shop	Smackover, Ark.
665		Section of heating boiler cracked			Mohair Realty Co.	Store and Apts.	New York, N. Y.
666	17	Steam main ruptured			Hammermill Paper Co.	Paper Mill	Erie, Pa.
667		Boiler bulged and ruptured			City Light & Water Plant	Power Plant	Huntingdon, Tenn.
668	18	Section of heating boiler cracked			Highland Hospital, Inc.	Hospital	Asheville, N. C.
669		Section of heating boiler cracked			David Migdalof	Apartment House	Brooklyn, N. Y.
670	19	Section of heating boiler cracked			Gluck Brothers, Inc.	Furniture Factory	Brooklyn, N. Y.
671		Tube ruptured			Penn. Iron & Steel Co.	Steel Plant	Creighton, Pa.
672		Tube ruptured			Morton Salt Co.	Salt Plant	Port Huron, Mich.
673		Sections of heating boiler cracked			Kaufman Clothing Co.	Store	Lexington, Ky.
674	20	Boiler exploded	2		S. S. Marion	Steamer	Morgant'n, W.Va.
675		Section of heating boiler cracked			The Pelham Trust	Office Bldg.	Boston, Mass.
676		Section of heating boiler cracked			Children's Aid Society	Health Station	New York, N. Y.
677	21	Two boilers exploded	12	23	Loreauville Sugar Co.	Sugar Plant	Loreauville, La.
678	23	Boiler exploded			St. Joseph's Convent	Convent	Brooklyn, N. Y.
679		Tube ruptured			B. & O. R. R. Company	Railroad	Baltimore, Md.
680		Four sections heating boilers cracked			Isaac Ruby	Apartment House	Dorchester, Mass.
681	24	Boiler exploded	1	1	Brown Hardwood Lumber Co.	Lumber Mill	Carthage, Tex.
682	25	Section of heating boiler cracked			Hale Bros., Inc.	Hotel and Theatre	Sacramento, Cal.

683		Section of heating boiler cracked			P. & L. Realty Corp.	Apartments	Brooklyn, N. Y.
684	26	Manifold of heating boiler cracked			Isidore Wise	Stores and Offices	Hartford, Conn.
685		Section of heating boiler cracked			Methodist Episcopal Church	Church	Conway, Ark.
686		Non-return stop valve ruptured			David Weber & Co., Inc.	Paper Box Factory	Philadelphia, Pa.
687	27	Air cyclinder exploded		2	Sonken-Galamba Corpn.	Iron Works	Kansas City, Kan.
688		Tube ruptured			Illinois Maintenance Co.	Office Building	Chicago, Ill.
689		Two sections heating boiler cracked			Parsons Theatre, Inc.	Theatre	Hartford, Conn.
690	29	Blow-off pipe failed			Kansas Flour Mills Co.	Flour Mill	Cherokee, Okla.
691		Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
692	30	Boiler bulged and ruptured			Illinois Wesleyan University	University	Bloomington, Ill.
693		Crown sheet of locomotive failed			The France Co.	Stone Contractors	Greencastle, Ind.
694		Boiler bulged and ruptured			St. Joseph Coal Mining Co.	Coal Mine	Vibbard, Mo.

MONTH OF DECEMBER, 1923.

695	1	Boiler bulged and ruptured			Mound City Box Company	Box Factory	St. Louis, Mo.
696		Packing blew out of guage glass			H. Graff, Inc.	Wholesale House	Chicago, Ill.
697		Section of heating boiler cracked			Jake Greenberg	Office Bldg.	Louisville, Ky.
698		Five sections heating boiler cracked			First M. E. Church	Church	Meriden, Conn.
699		Boiler exploded			Armour & Co.	Packing House	Muskogee, Okla.
700		Two sections heating boiler cracked			State Normal School	School	Athens, Ga.
701	3	Blow-off cocks failed			E. U. Scoville Co.	Machine Shop	Manlius, N. Y.
702		Five sections heating boiler cracked			The Buckeye Coal Co.	Hospital	Nemacolin, Green Co., Pa.
703	5	Upper tube sheet failed		1	Smith & Kelly Co.	Stevedoring	Savannah, Ga.
704		Section and manifold of heating boiler cracked			L. H. & E. B. Shearman	Country Estate	Herricks, L. I., N. Y.
705	6	Section of heating boiler cracked			City of Waterbury	Fire Station	Waterbury, Conn.
706	7	Accident to boiler			Board of Education	School	Harrisonville, Mo.
707		Header cracked			Monsanto Chemical Works	Chemical Plant	St. Louis, Mo.
708	8	Section of heating boiler cracked			State Agricultural College	University	Burlington, Vt.
709		Blow-off pipe ruptured			Harlan & Lowe Milling Co.	Flour Mill	Bardwell, Ky.
710		Five headers cracked			Loose-Wiles Biscuit Co.	Cracker Bakery	Kansas City, Mo.
711	10	Blow-off pipe failed			Audrey Spinning Mill, Inc.	Spinning Mill	Weldon, N. C.
712		Tube ruptured		1	Caddo-DeSoto Cotton Oil,Co., Inc.	Oil Mill	Mansfield, La.
713		Two sections heating boiler cracked			Richmond Chase Company	Fruit Packers	San Jose, Cal.
714		Two sections heating boiler cracked			118 Madison Ave Co.	Loft Bldg.	New York City
715		Two sections heating boiler cracked			Long Lane Farm	Farm	Middletown, Conn.

MONTH OF DECEMBER, 1923 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
716	10	Two sections heating boiler cracked			Country Club	Club House	Brookline, Mass.
717	11	Boiler ruptured			The Laundry Co.	Laundry	Maplewood, Mo.
718	12	Boiler ruptured			The Watt Pottery	Pottery	Crooksville, O.
719	13	Five sections heating boiler cracked			W. Fox	Stores and Billiard Room	New York City
720	14	Crown sheet failed		1	Savage Manufacturing Co.	Cotton Mill	Savage, Md.
721		Thirteen tubes ruptured			The Amalgamated Sugar Co.	Sugar Mill	Lewiston, Utah
722	15	Boiler exploded	1		Olaffson's Camp		Manson's Landing, V. I., Canada
723		Section of heating boiler cracked			O. B. & A. J. Stevens	Florist	Shenandoah, Ia.
724		Five sections heating boiler cracked			Theo. Hamm Brewing Co.	Restaurant and Office	St. Paul, Minn.
725	16	Seven sections heating boiler cracked			Hyland, Rood & Webster	Business Block	Springfield, Mass.
726	17	Boiler of locomotive exploded	2		C. B. & Q. R. R. Co.	Railroad	Kirby, Wyo.
727		Section of heating boiler cracked			First National Bank	Bank Bldg.	Hastings, Neb.
728	19	Section of heating boiler cracked			Virginia Hotel	Hotel	Emporia, Va.
729		Boiler exploded				Oil Well	Haymaker, Pa.
730		Section of heating boiler cracked			The Atkins Company	Stores	Hartford, Conn.
731		Tube ruptured			The Antlers Hotel Co.	Hotel	Colorado Springs, Col.
732	20	Two sections heating boiler cracked			Goodmon, Armon & Goodman	Store	Philadelphia, Pa.
733	21	Six sections heating boiler cracked			John Mayer	Apartment House	Kansas City, Mo.
734		Section of heating boiler cracked			Hagemeier Upholstering Co.	Upholstering	Pittsburgh, Pa.
735	22	Tube ruptured			American Brick Co.	Brick Plant	New Orleans, La.
736	23	Section of heating boiler cracked			P. & L. Realty Corpn.	Apts. and Stores	Brooklyn, N. Y.
737		Blow-off pipe failed			What Cheer Laundry	Laundry	Providence, R. I.
738	24	Boiler exploded	1		4636 Broadway		Chicago, Ill.
739		Boiler bulged and ruptured			Royal Palm Ice & Refrig. Co.	Ice Plant	Miami, Fla.
740		Section of heating boiler cracked			Geo. A. Goudie	Residence	Kansas City, Mo.
741	25	Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
742		Header cracked			Utah-Idaho Sugar Co.	Sugar Mill	Garland, Utah
743	26	Section of heating boiler cracked			Sowers Mfg. Co.	Foundry	Buffalo, N. Y.
744		Blow-off pipe failed			McKinney Steam Laundry	Laundry	McKinney, Tex.

745		Tube ruptured			The Eddy Paper Corpn.	Paper Mill	Three Rivers, Mich
746	27	Section of heating boiler cracked			Morrill Public Library	Library	Hiawatha, Kan.
747		Four sections heating boiler cracked			Connellsville Macaroni Co.	Macaroni Factory	Connellsville, Pa.
748		Three sections heating boiler cracked			E. E. & C. F. Luthy	Offices and Stores	Albuquerque, N. M.
749		Section of heating boiler cracked			St. Luke's Church	Church	Evanston, Ill.
750		Section of heating boiler cracked			J. J. Agneli	Apartment House	San Francisco, Cal.
751	28	Three sections heating boiler cracked			Geo. H. Bishop	Office Bldg.	Norfolk, Neb.
752		Air tank exploded			New Way Auto Laundry	Garage	St. Louis, Mo.
753	29	Section of heating boiler cracked			St. Louis Woman's Club	Club House	St. Louis, Mo.
754		Boiler ruptured			McKinley Cleaning Co.	Cleaning and Dyeing	Portland, Ore.
755	31	Hot water heater exploded		1	Ord Journal	Publishers	Ord Neb.

MONTH OF JANUARY, 1924.

1	1	Blow-off pipe failed			Boulevard Dairy Co., Inc.	Dairy	Albany, N. Y.
2		Boiler exploded		1	101 Ranch	Ranch	Ponca City, Okla.
3		Tube ruptured			Milwaukee Coke & Gas Co.	Gas & Chem. Plt.	Milwaukee, Wis.
4		Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
5		Feed pipe failed			Robertson Paper Co., Inc.	Wax Paper Factory	Bellows Falls, Vt.
6		Three sections heating boiler cracked			Westwood Country Club	Country Club	Glendale, Mo.
7	2	Five sections heating boiler cracked			School District No. 2	School	Union Gap, Wash.
8	3	Tubes failed			George A. Henderson	Stores	Sterling, Colo.
9		Tubes ruptured			J. J. Newman Lbr. Co.	Lumber Mill	Sumrall, Miss.
10		Blow-off pipe failed			Temple-Stuart Co.	Chair Factory	Baldwinville, Mass.
11		Three sections heating boiler cracked			Finlay	Boarding House	Greenville, S. C.
12	4	Section of heating boiler cracked			Board of Education	School	Canton, Ohio
13		Section of heating boiler cracked			Estate of Thos. R. Lyon	Office Bldg.	Chicago, Ill.
14		Section of heating boiler cracked			Andrean Realty Co.	Store & Apartment	Brooklyn, N. Y.
15	5	Furnace collapsed			Albert Pick & Co.	Hotel Supplies	Chicago, Ill.
16		Tube ruptured			Rockford Paper Box BoardCo.	Box Board Mill	Rockford, Ill.
17		Tube ruptured			Birmingham Terminal Co.	Power Plant	Birmingham, Ala.
18	6	Boiler exploded			Russel & Meredith	Garage	Boonsboro, Md.
19		Section of heating boiler cracked		3	Sigma Nu Fraternity	Fraternity House	Galesburg, Ill.
20		Section of heating boiler cracked			J. M. & N. Gorton	Millinery Shop	Racine, Wis.
21		Two sections heating boiler cracked			John Will Adams	Apartment House	Kansas City, Mo.
22		Three sections heating boiler cracked			Air Reduction Co., Inc.	Store House	New York, N. Y.
23		Several sections heating boiler cracked			Farnsworth & Hartman	Apartment House	Detroit, Mich.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1923

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$507,869.87
Real Estate	255,000.00
Mortgage and collateral loans	1,818,750.00
Bonds and stocks	8,414,500.82
Premiums in course of collection	1,029,559.34
Interest Accrued	140,348.10
Total assets	$12,166,028.13

LIABILITIES

Reserve for unearned premiums		$5,530,427.71
Reserve for losses		318,407.05
Reserve for taxes and other contingencies		457,030.70
Capital stock	$2,500,000.00	
Surplus over all liabilities	3,360,162.67	
Surplus to Policyholders,		**$5,860,162.67**
Total liabilities		$12,166,028.13

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Trusees, United States Security Trust Co., Hartford, Conn.

LUCIUS F. ROBINSON, Attorney, Hartford, Conn.

JOHN O. ENDERS, President, United States Security Trust Co., Hartford, Conn.

MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.

CHARLES P. COOLEY, Pesident, Society for Savings, Hartford, Conn.

HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.

D. NEWTON BARNEY, Vice-President, The Hartford Electric Light Co., Hartford, Conn.

DR. GEORGE C. F. WILLIAMS, President and Treasurer. The Capewell Horse Nail Co., Hartford, Conn.

JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.

EDWARD MILLIGAN, President. The Phœnix Insurance Co., Hartford, Conn.

MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.

CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.

WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.

SAMUEL M. STONE, President, Colts Patent Fire Arms Mfg. Co., Hartford, Conn.

SAMUEL FERGUSON, President. The Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866 THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Reeresentatives
ATLANTA, Ga.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abel Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn.,	W. G. Lineburgh & Son, General Agents.
404-405 City Savings Bank Bldg.	A. E. Bonnet, Chief Inspector.
CHICAGO, Ill.,	P. M. Murray, Manager.
209 West Jackson B'l'v'd	J. P. Morrison, Chief Inspector.
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio.	W. E. Gleason, Manager.
First National Bank Bldg.	Walter Gerner, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chesnutt.
916-918 Gas & Electric Bldg.	Manager and Chief Inspector.
HARTFORD, Conn.,	F. H. Kenyon, General Agent.
56 Prospect St.	A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector.
Hibernia Bank Blg.	E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y.	C. C. Gardiner, Manager.
80 Maiden Lane	E. Mason Parry, Chief Inspector.
	R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	Bates, Lively & Pearson, Gen'l Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
305-306 Thompson Bldg.	
SAN FRANCISCO, Cal.,	H. R. Mann & Co., General Agents.
339-341 Sansome St.	J. B. Warner, Chief Inspector.
ST. LOUIS, Mo.,	C. D. Ashcroft, Manager.
319 North Fourth St.	Eugene Webb, Chief Inspector.
TORONTO, Canada,	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.
Federal Bldg.	

CARNEGIE LIBRARY
DEC 1 - 1924
OF PITTSBURGH, PENNA

Does Your Fireman Know

How to prevent the formation of clinkers?

How to clean a fire skillfully?

Whether or not he is obtaining good combustion?

The advantages of a steady water line?

How to "cut in" a boiler safely?

The proper method of testing the water gauge glass?

How to cool down a boiler safely under emergency conditions?

These are only a very few of the questions answered in the Hartford's Correspondence Course for Firemen.

Fill out the blank below and send for further information.

THE HARTFORD STEAM BOILER
INSPECTION & INSURANCE CO.,
HARTFORD, CONN.

Please send me further details of your Correspondence Course for Firemen

Name ....

Address ....

....

O-24.

CARNEGIE LIBRARY
DEC 1 - 1924
OF PITTSBURGH, PENNA

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXV. HARTFORD, CONN., JANUARY, 1925. No. 5.

COPYRIGHT, 1925, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

PUMPING ENGINE ACCIDENT AT NEWARK, OHIO.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Pumping Engine Accident at Newark, Ohio

THE city of Newark, Ohio, suffered a serious accident to one of its large pumping engines at the city water works on May 10, 1924.

The engine, a Corliss compound engine with 20 inch and 40 inch diameter cylinders, was running under normal conditions at a speed of 24 r. p. m. at the time of the accident. The engineer states that he was standing at the water end of the high pressure side greasing the guides and plungers when the engine began pounding violently. He rushed to the throttle valve and closed it, but was not in time to prevent the engine from wrecking itself.

The initial break appears to have been in the strap on the crank end of the connecting rod. This break shows very clearly in the illustration on the front cover. Released from the crank, the reciprocating parts were evidently driven forcibly against the head end of the cylinder.

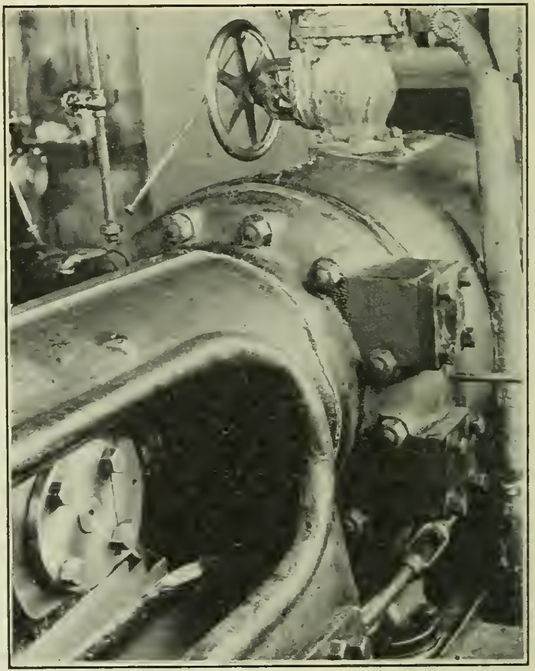


FIG. 1.

The most serious damage was the breaking of the main frame. This casting was 17 ft. in length, and the steam cylinder end was completely severed from the rest of the frame, as shown in Fig 1. When the cylinder moved to open up this crack, it also cracked the body of the throttle valve completely around. Besides the break in the strap, the connecting rod was bent. The piston was cracked in five places. The piston rod at the water end was broken off at the cross-head, and the cross-head itself was broken. The stuffing box gland at the water end was broken and the parallel rods, which connected the steam and water pistons, were badly bent and twisted. On account of the large casting which had to be replaced, repairs were expected to require considerable time. The engine was built in 1907.

The property loss in the accident was covered by a "Hartford Steam Boiler" policy.

The Efficiency of Reinforced Tube Ligaments

By G. H. Stickney, Sup't, Boiler Department,
and
B. C. Cruickshanks, Editor.

THE strongest part of a steam boiler is the original solid plate, and whenever this plate is cut, no matter what well designed joint is substituted, the boiler is weakened. It is readily apparent, therefore, that in the cross drum type of boiler, where rows of tubes running the full length of the drum must enter the drum, and the efficiency is to be increased, some reinforcement must be provided to replace the metal cut out to accommodate these tubes. For instance, if we have a four inch tube ($4\frac{1}{32}$ inch hole) entering the drum every seven inches of its length, there would be but $7 - 4\frac{1}{32} = 2\frac{31}{32}$ inches of metal left intact between the tubes. The efficiency of such a tube ligament, as we call it, would be

$$\frac{P - D}{P} = \frac{7 - 4\frac{1}{32}}{7} = 42.4\%.$$

Without some form of reinforcing, our boiler would then be good for only about one-half of the pressure that it might otherwise safely carry. These ligaments are usually reinforced by riveting on one or two cover plates or straps, and it is the purpose of this article to consider one or two typical cases and show the method of computing the efficiencies.

It is assumed that those who will attempt to follow our methods and calculations are already familiar with the approved methods of computing the efficiencies of riveted joints, and so definitions will be dispensed with here. Some of the fundamental laws of mathematics, with which, by the way, every engineer should become acquainted and which will be of material assistance in enabling us to use formulæ and thereby present our work more clearly and concisely, will be briefly reviewed.

These laws can best be considered in connection with an expression of which we will make much use, that is, [(P — nd)t x TS]. Each letter in this expression stands for a certain number or numerical value, and when two letters are written together, as *nd,* it simply means that the corresponding numbers are to be multiplied together, just as if written *n* x *d*.

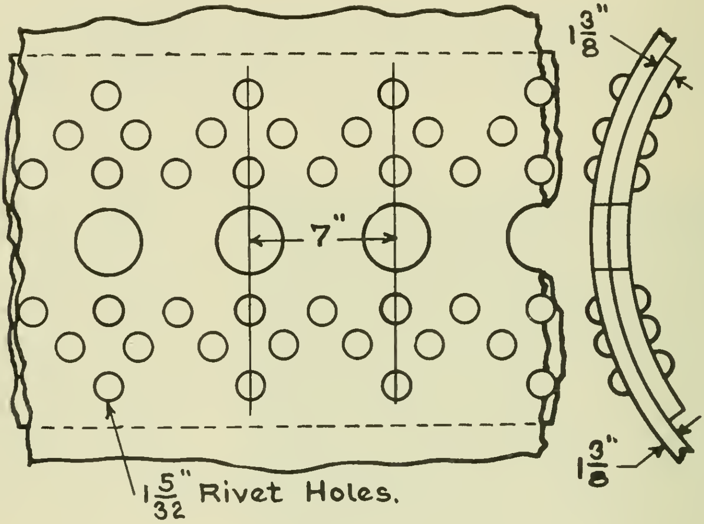


Fig. 1.

Likewise, the *t* placed next to the parentheses, ( ), without any intervening sign means that the *t* is to be multiplied by the "value of the parentheses."

The parentheses point out to us that the operations indicated by the signs within them must be performed first and a single number or numerical value be thus arrived at, which is called the "value of the parentheses." It is this value that is multiplied by *t*.

In the same way, the brackets, [ ], mean that the operations indicated by the signs within them must be performed before removing the brackets so as to obtain a value for the bracketed expression.

Let us first consider a case of reinforced tube ligaments such as the one illustrated in Fig. 1. Here we have a single row of tubes entering a drum, and the reinforcing is by means of an inside cover plate, triple riveted. For all of our calculations we will assume the following values which are approved by the A. S. M. E. Boiler Construction Code.

TS = tensile strength of boiler plate = 55,000 lbs. per sq. in.
s = shearing strength of rivet in single shear = 44,000 lbs. per sq. in.
S = shearing strength of rivet in double shear = 88,000 lbs. per sq. in.
c = crushing strength of boiler plate = 95,000 lbs. per sq. in.

From the sketch, Fig. 1, we obtain the following values:

P = unit distance, that is, the shortest distance, measured along the drum, that will include a whole number of tubes and a whole number of rivets = 7 inches.
D = diameter of tube holes = $4\frac{1}{32}$ inches = 4.031 inches
d = diameter of rivet holes = $1\frac{5}{32}$ inches = 1.156 inches
a = cross-sectional area of rivet after driving = 1.049 inches
t = thickness of plate = $1\frac{3}{8}$ inches = 1.375 inches
b = thickness of cover plate = $1\frac{3}{8}$ inches = 1.375 inches
n = number of rivets in outer row per unit distance = 1
m = number of rivets in second row per unit distance = 2

In obtaining the efficiency of reinforced tube ligaments, the procedure at first is exactly like that of obtaining the efficiency of riveted joints. The joint must be analyzed, that is, all the various ways in which it might fail are thought out, and then the force that would be required in each instance to make it fail is computed. The mode of possible failure that proves the weakest is then compared in strength with the strength of the solid plate. The result, expressed in percentage, is the efficiency of the ligament.

The strength of the solid plate in this instance is

$$\begin{aligned} A &= (P \times t \times TS) = \\ &= (7 \times 1.375 \times 55{,}000) \\ &= 530{,}000 \text{ lbs.} \end{aligned}$$

As the first possible mode of failure, let us consider failure of the plate along the outer row of rivets. The force required for this type of failure, or what is the same thing, the strength of the drum along this line, is the strength of the net section of plate, or

$$\begin{aligned} B &= (P - d)t \times TS \\ &= (7 - 1.156)1.375 \times 55{,}000 \\ &= 442{,}000 \text{ lbs.} \end{aligned}$$

Consider next the possibility of failing along the second row of rivets. If failure occurs along this line, not only will the strength of the net section of plate have to be overcome, but also the outside row of rivets must be accounted for. Thus we may have

C = [strength of net section of plate between rivets in 2nd row] + [shearing strength of rivets in outer row]

$$\begin{aligned} &= [(P - \overline{md})t \times TS] + [n \times a \times s] \\ &= [(7 - \overline{2 \times 1.156})1.375 \times 55{,}000] + [1 \times 1.049 \times 44{,}000] \end{aligned}$$

$= [354{,}500] + [46{,}200]$
$= 400{,}700$ lbs.

or $D =$ [strength of net section of plate between rivets of 2nd row] + [crushing strength of shell in front of rivets in outer row]

$$= [(P - \underline{\overline{md})t \times TS}] + [n \times t \times d \times c]$$
$$= [(7 - 2 \times 1.156)1.375 \times 55{,}000] + [1 \times 1.375 \times 1.156 \times 95{,}000]$$
$$= [354{,}500] + [151{,}000]$$
$$= 505{,}500 \text{ lbs.}$$

Failure along the third or inside row of rivets will not be considered because it is quite apparent that the drum is stronger here than at the second row. Having the same number of rivets per unit distance in each row, the net section of plate is the same in each case, but a break along the inner row has the additional (second) row of rivets to be also overcome by shearing or crushing.

The next mode of failure would then be through the plate between the tubes. The strength here is not only that of the net section of plate remaining between the tubes, but also the failure of all rivets in one way or another is required. This might be either

$E =$ [strength of net section of shell plate between tubes] + [shearing strength of all rivets]

$$= [(P - D)t \times TS] + [n \times a \times s]$$
$$= [(7 - 4.031)1.375 \times 55{,}000] + [5 \times 1.049 \times 44{,}000]$$
$$= [224{,}500] + [230{,}600]$$
$$= 455{,}100 \text{ lbs.}$$

or $F =$ [strength of net section of shell plate between tubes] + [crushing strength of plate in front of all rivets]

$$= [(P - D)t \times TS] + [n \times t \times d \times c]$$
$$= [(7 - 4.031)1.375 \times 55{,}000] + [5 \times 1.375 \times 1.156 \times 95{,}000]$$
$$= [224{,}500] + [755{,}000]$$
$$= 979{,}500 \text{ lbs.}$$

Formula "F" can usually be neglected without computing its value because its value, as a rule, is high. It is not advisable to do this, however, until one is thoroughly acquainted with riveted joint calculations.

A comparison of the various values of B, C, D, E, and F shows

C to be the smallest. The efficiency of the construction shown in Fig. 1, is therefore

$$\frac{C}{A} = \frac{400{,}700}{530{,}000} = 75.6\%.$$

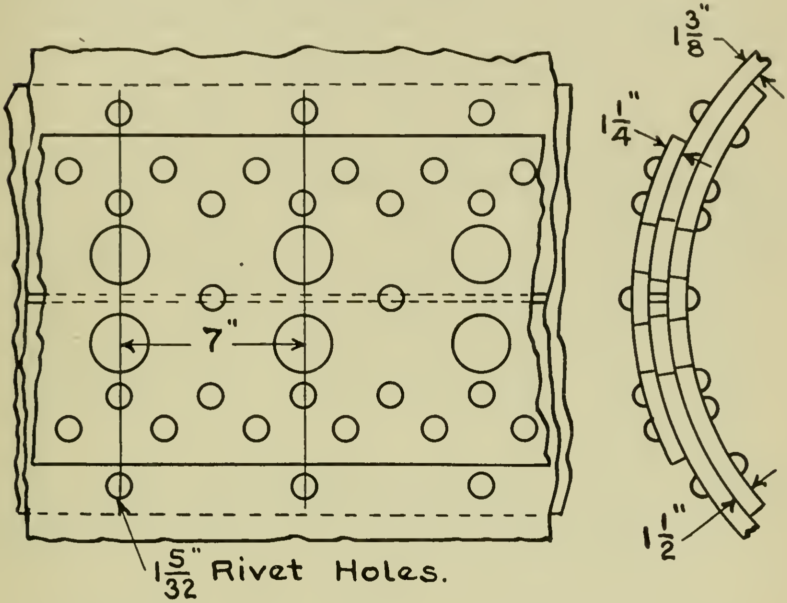


Fig. 2.

Another type of reinforced tube ligament which is quite frequently met is shown in Fig. 2. Here we have two rows of tubes entering the drum running parallel to, and alongside of, the butt seam. In this way double use is made of the cover plates, first, as butt straps for the seam, and second, as reinforcement for the tube ligaments. The method to be followed in analyzing this construction for efficiency is similar to the one above. It should be noted, however, that some of the rivets here are in double shear.

From the sketch, Fig. 2, we obtain the following dimensions:

P = unit distance, that is, the shortest distance, measured along the drum, that will include a whole number of tubes and a whole number of rivets = 7 inches
d = diameter of rivet holes = 1 5/32 inches = 1.156 inches
a = cross-section area of rivets = 1.049 sq. inches
t = thickness of shell plate = 1 3/8 inches = 1.375 inches
b = thickness of inside cover plate = 1 1/2 inches = 1.50 inches
b_0 = thickness of outside cover plate = 1 1/4 inches = 1.25 inches
n = number of rivets per unit distance in outer row = 1
m = number of rivets per unit distance in second row = 2
N = total number of rivets per unit distance in double shear = 4

The strength of the solid plate is found as in the previous case.

$$A = (P \times t \times TS) = (7 \times 1.375 \times 55{,}000)$$
$$= 530{,}000 \text{ lbs.}$$

As a possible mode of failure, let us again consider first failure along the outer row of rivets. The strength of the vessel at this line is

$$B = [(P - d)t \times TS]$$
$$= [(7 - 1.156)1.375 \times 55{,}000]$$
$$= 442{,}000 \text{ lbs.}$$

Next consider failure along the second row of rivets. The strength here is

C = [strength of net section of plate between rivets in 2nd row] + [shearing strength of rivets in outer row]

$$= [(P - md)t \times TS] + [n \times a \times s]$$
$$= [(7 - 2 \times 1.156)1.375 \times 55{,}000] + [1 \times 1.049 \times 44{,}000]$$
$$= [354{,}500] + [46{,}200]$$
$$= 400{,}700 \text{ lbs.}$$

or D = [strength of net section of plate between rivets in 2nd row] + [crushing strength of shell or strap (which ever is thinner) in front of rivets in outer row]

$$= [(P - md)t \times TS] + [n \times d \times t \times c]$$
$$= [(7 - 2 \times 1.156)1.375 \times 55{,}000] + [1 \times 1.156 \times 1.375 \times 95{,}000]$$
$$= [354{,}500] + [151{,}000]$$
$$= 505{,}500 \text{ lbs.}$$

As explained previously, on page 134, failure along the third row is very unlikely as the strength of the vessel here would be that of C or D above plus the additional strength due to the extra (second) row of rivets.

The next mode of failure considered is by separation of the seam where the two edges of the shell meet. Tearing between the tubes is not considered because there is nothing holding the portion of the shell which projects beyond the tubes. The single row of rivets down the middle of the seam is placed there merely to tie the three thicknesses of plate together and prevent buckling because of the wide space between the two inner rows of rivets. It should furthermore be noted that no allowance will be made for any strengthening effect due to the tubes, as a safe value for the resistance of the tubes against crumpling would be very small. Considering separation at the seam, the strength would be

$$\begin{aligned} E &= [\text{shearing strength of all rivets}] \\ &= (N \times a \times S) + (n \times a \times s) \\ &= (4 \times 1.049 \times 88{,}000) + (1 \times 1.049 \times 44{,}000) \\ &= (369{,}000) + (46{,}200) \\ &= 415{,}200 \text{ lbs.} \end{aligned}$$

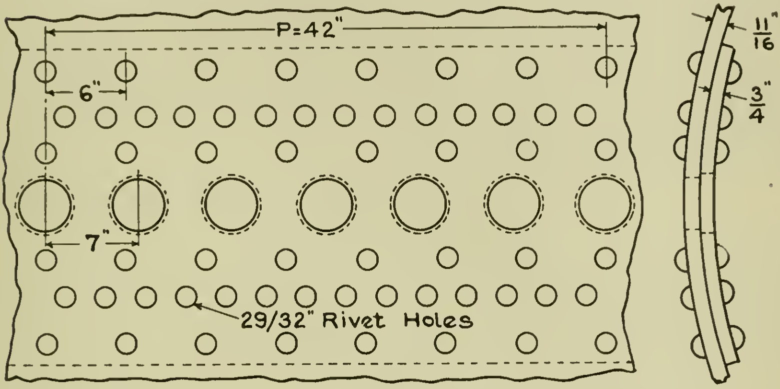


FIG. 3.

$$\begin{aligned} F &= [\text{crushing strength of plate in front of all rivets}] \\ &= (\text{total rivets} \times d \times t \times c) \\ &= (5 \times 1.156 \times 1.375 \times 95{,}000) \\ &= 755{,}000 \text{ lbs.} \end{aligned}$$

$$\begin{aligned} G &= [\text{crushing strength of plate in front of rivets of inner and 2nd} \\ &\qquad \text{rows}] + [\text{shear of rivets in outer row}] \\ &= (N \times d \times t \times c) + (n \times a \times s) \\ &= (4 \times 1.156 \times 1.375 \times 95{,}000) + (1 \times 1.049 \times 44{,}000) \\ &= (604{,}000) + (46{,}200) \\ &= 650{,}200 \text{ lbs.} \end{aligned}$$

or

$$\begin{aligned} H &\doteq [\text{strength of net section of both inner and outer straps at 2nd} \\ &\qquad \text{row of rivets}] + [\text{shearing strength of 2 rivets, in double} \\ &\qquad \text{shear, in inner row}] \\ &= [(P - \overline{md})\ (b + b_0) \times TS] + [N \times a \times S] \\ &= [(7 - \overline{2 \times 1.156})\ (1.50 + 1.25) \times 55{,}000] + [2 \times 1.049 \\ &\qquad \times 88{,}000] \\ &= [710{,}000] + [184{,}600] \\ &= 894{,}600 \text{ lbs.} \end{aligned}$$

A comparison of the results shows C to be the lowest. Therefore the efficiency of the construction shown in Fig 2 is

$$\frac{C}{A} = \frac{400{,}700}{530{,}000} = 75.6\%.$$

A slight variation of the problem is presented by the construction shown in Fig. 3. This is similar to Fig. 1, but it will be noted that the pitch of the tubes is 7 inches and the maximum pitch of the rivets is 6 inches. In order to obtain a value for P, a distance that will contain a whole number of tubes and a whole number of rivets, it will be necessary to find the least common multiple of 7 inches and 6 inches, or 42 inches. With this value of P and the proper corresponding values for the other letters in our formulæ, the efficiency of this joint should be approximately 82%.

A Letter From Wisconsin.

Gentlemen:

This is to acknowledge receipt of your favor of the 27th Ins't informing us that you received a box containing a bottle of Boiler feed water minus the bottle, it certainly beats *H*— the luck we are haveing in getting a bottle of plain unadulterated *Water* through to Hartford, evidently some Proabition *Crank* thought he had a snap and confiscticated the bottle thinking he had found a bottle of the real goods, but we must say if we had such a bottle we would not take a chance on shipping it as it would be too precious.

We are shipping you an other sample to day by express all Charges prepaid, and hope that it will reach you, although we would not be surprized if it were frozen up before it gets there as we are haveing a cold wave here to day with the Thermometer around 20 degrees, which is some weather even in Wisconsin at this time of the year.

Yours truly,

A Warm Reception.

Windfall, Ind.— Dr. H. J. Corn was suffering from serious scalds on the right side and arm received in an explosion of a hot water heating plant at the Christian Church parsonage here. Dr. Corn was assisting Will Riffe in preparing the furnace for the arrival of the new minister, the Rev. Syfers. The explosion wrecked the furnace.

—*Indianapolis Times.*

The Value of Inspections.

Checking Up on Repairs.

FROM time to time we have endeavored to point out the value of inspections by calling attention to some of the serious defects uncovered. More recently, in the July, 1924, issue of The Locomotive, there were mentioned several discoveries made by our inspectors which it is believed would most likely have been passed over by men less experienced in this work. The value of the inspector, however, does not lie solely in finding latent defects, but frequently after repairs have been made he is called upon to pass judgment upon the efficacy and safety of the job. The following incidents show some of the types of repairs he is called upon to approve and further indicate that, even when a boiler is found defective, many operating engineers and boiler makers do not appreciate the seriousness of the trouble nor how to properly remedy it.

As one of the most serious of all boiler defects, the lap seam crack is perhaps the best one with which to begin. An inspector, called in because of serious leakage to a boiler, found a crack 28 inches long. A local boiler maker had already attempted to make repairs but apparently with little success. One half inch holes had been drilled along the crack at intervals of 1¼ inches and plugged with rivets. It is remarkable that an explosion did not occur, as the boiler had been under pressure several times since the crack was first discovered. The danger was not realized.

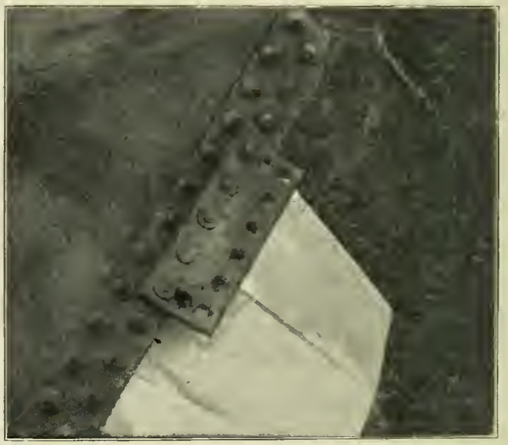
It is interesting, in this connection, to recall a case which illustrates the necessity of a final inspection. A crack had been discovered and marked, and the recommendation made that it be cut out and the plate patched. The crack was evidently invisible to the boiler maker for, although it had been marked, the inspector found that an adjacent portion of the plate had been replaced by the patch, and the crack remained as prominent as ever.

The timely visit of an inspector, who was making his usual rounds undoubtedly prevented a veritable epidemic of explosions in one state not long ago. It was found that a number of horizontal tubular boilers had recently been patched, the patches being simply welded onto the shell, and in a great many cases were right over the fire. Evidently some one had just procured a welding outfit and started out to drum up business and revolutionize boiler repair methods. The prompt suspension of insurance in each case pending replacement with properly riveted patches must certainly have emphasized the inspector's opinion of the work.

On another occasion a well-known boiler repair shop replaced a half sheet on a boiler in a thoroughly workmanlike manner. The inspector's examination, however, revealed that instead of boiler plate being used ordinary tank steel had been inadvertently substituted. The brand was plainly visible.

A novel method of repairing tubes in a vertical tubular boiler was discovered a few years ago. A wooden plug would be fitted into the bottom of the tube and the tube filled with concrete. The plug would burn out but the concrete would stay. This method evidently stopped the leaks but is not guaranteed to prevent the tube sheets from blowing out. The inspector found nine such tubes in one boiler. Investigation revealed that all of the tubes were seriously corroded at the water line. A complete new set was recommended.

An interesting case is that of a horizontal tubular boiler which was giving trouble due to leakage at the bottom of both girth seams. A boiler maker from a nearby shop was called in to rectify the trouble. His first attempt at caulking was unsuccessful and so he was called back a second and even a third time. Finally the owners decided it was time to call a "Hartford" inspector. Inspection revealed cracks running from rivet hole to rivet hole almost completely around the boiler. The cracks were in the inside sheet and were not visible to the boiler maker from the outside. Evidently the tubes were holding the boiler together. The owner was in a quandary as he could not well afford to shut down the plant, yet all three of the boilers were over one furnace and trouble with one affected all three. The inspector offered a solution. He suggested that the defective boiler be cut off from the line and filled with water and the manhole left open. A wooden flue was constructed around the manhole opening to carry off the vapor, and, by keeping this boiler full, the plant was able to keep going for a couple of weeks, after which the boiler was removed.



Soft Patch Used in an Unsuccessful Attempt to Repair a Longitudinal Seam Crack.

When an insured boiler is to be repaired, the inspector usually receives a call and his advice asked before the work is started. Naturally, freak and dangerous repairs are not very commonly found on inspected boilers. Many such are found, however, on boilers not subject to inspection, and they are most frequently brought to our attention through explosions. An interesting case is that of an experience with a patch used to repair a longitudinal seam crack in a vertical tubular boiler. The accompanying photograph gives some of the details. This soft patch was bolted on, but it was decided not to take a chance with the boiler in this condition, so it was relegated to pumping duty at "very light pressure." It eventually exploded, fatally injuring the operator. The line of rupture, of course, was along the crack. Investigation revealed that the crack ran practically the full length of the course. The five bolts in the patch were therefore doing most of the work of holding this section of the boiler together.

What appears to be a better way of repairing a crack of this nature is by means of a riveted patch. One would naturally suppose that, with a visible crack to be repaired by a riveted patch, an acceptable job could be done by almost any mechanic. You can imagine the surprise of the inspector who, upon investigating the explosion of a boiler which incidentally was not insured, found that the immediate cause of failure was a repair job of this type. A lap seam crack had been patched in such a manner that the defective plate was weakened rather than strengthened. The patch had been so applied that the row of rivets along one side of the patch was centered on the crack. Naturally, the boiler failed the next time it was fired up. Two boys were killed and one man probably fatally injured.

Both of the above accidents happened to boilers in which cracking had proceeded to such a stage that serious leakage was actually taking place. The danger should have been realized by any one familiar with boiler construction. Needless to say, an inspector would have recommended suitable repairs and would have followed them through to see that the resulting job was a safe one.

Leakage around a through stay or staybolt receives careful attention from an inspector though operators frequently pay little attention to it. The explosion of a locomotive type boiler in a city on the western coast was found to be due to a lack of understanding of the significance of staybolt leakage. Seven-eighths inch diameter staybolts had been used in the construction of the boiler which had ¼ inch firebox and wrapper sheets. Serious corrosion of the wrapper sheet caused considerable leakage around the staybolts. Examination showed the plate very thin around the holes and so it was decided to remedy the trouble by using larger staybolts. The holes were reamed and tapped and 1⅛ inch diameter staybolts inserted. Corrosion continued, however, and the plate around these larger staybolts was soon as thin as it had been around the smaller ones. Attempts to stop leakage had again been made by caulking. The trouble was finally ended by the failure of the boiler, the wrapper sheet having pulled away from the staybolts. One man was injured. Had the advice of a competent inspector been obtained, this explosion would undoubtedly have been avoided.

One of the through stays in the lower part of a Scotch Marine boiler had been leaking. The outer nut and washer were removed and new fibrous packing in the form of a grommet was put on the end of the stay. The nut and washer were then replaced. When the boiler was steamed up, the outer end of the through stay, including the nut and washer, was blown out. The stay, being broken off flush with the inside surface of the head, dropped down and left a hole 2½ inches in diameter. This hole was directly in line with the coal bunker, and the jet of steam issuing under 140 lbs. pressure fatally scalded the coal passer. The break in this through stay was clearly an old break and, though not discovered while repairing it, would most likely have been revealed by inspection.

Autogenously Welded Tank Failures.

THE unreliability of an autogenously welded joint is well demonstrated by the explosion of a brine cooling tank at the Jessup & Antrim Company, Indianapolis, Indiana, May 11, 1924, as a result of which one man was killed and six seriously injured.

An idea of the general design of the tank may be obtained from Fig. 1. The shell was of ⅜ inch plate and was 28 inches in diameter by 10 ft. long. The ends were autogenously welded to flange rings for the purpose of attaching the heads. The longitudinal seam was also welded. Brine was caused to enter the cast iron head and flow through the tubes, while ammonia surrounded the tubes.

It is reported that prior to the accident the welds gave every appearance of being sound. Under but 15 lbs. pressure, however, the shell separated along the whole length of the longitudinal seam and tore loose from the end rings. Examination of the wrecked tank disclosed that the weld extended in some places to a depth of but 1/16 inch, or but ⅛ of the thickness of the plate, well showing the hazard of this type of joint.

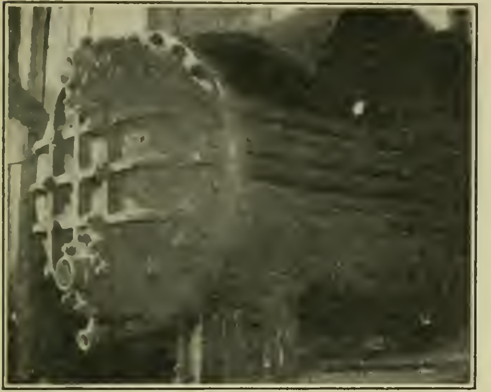


FIG. 1.

An accident of the same type but of very much more impressive dimensions, at least if measured by the casualty list, occurred August 28, 1924 in the basement of the South Side Grocery, Des Moines, Iowa. Eleven persons were killed and eight injured when a tank, used as generator and absorber in connection with an absorption refrigerating system, exploded.

The tank was 24 inches in diameter by 6 ft. long with slightly dished out, or plus, heads. Both shell and heads were of ⅜ inch plate, and all seams were autogenously welded, apparently by the electric arc method. The heads, it should be noted, were not flanged but were merely inserted and sealed on the outside by autogenous welding. The failure was in one of these welded head seams.

The exact cause of the explosion is not given, but an excerpt from the verdict of the coroner's jury states, "The cause of the explosion was due to faulty welding and failure of safety or relief valve to work at proper pressure." In quoting the above verdict we wish to call attention to the unusual character of this jury in that it was composed entirely of refrigerating engineers, a fact which makes itself quite evident in its report. Had the tank possessed a sufficient factor of safety, it is not unlikely that it might have held out long enough to release the safety valve. The saddest part of this explosion is the fact that eight of those killed were children.

Another similar accident but with less fatal results occurred not long ago at an automobile accessory station at Uniontown, Pennsylvania. This tank was used to supply air for automobiles and was 16 inches in diameter by 48 inches long. The shell was of $\frac{3}{16}$ inch plate with ¼ inch heads. It was of autogenously welded construction throughout, and the failure was in the weld.

Examination of this tank subsequent to the accident revealed a very imperfect weld in the longitudinal seam as shown in the part cross sectional view, Fig. 2. Only a small amount of metal, built up on the outside, held the tank together. The weakest part of the weld appeared to be about 6 inches from one end, though it is difficult to say where the rupture originated as the whole weld failed, even the head girth seams. The nature of the failure is clearly shown in Fig. 3.

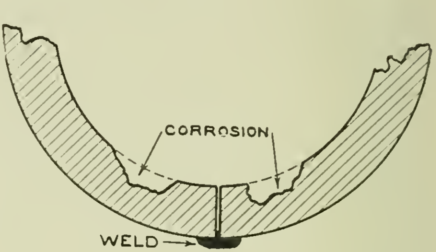


Fig. 2.

In connection with this accident it will not be amiss to point out the necessity for providing means for internal inspection of all pressure vessels no matter how small they may be. The poor condition of this weld would have been readily detected by such an inspection. In addition, as can be plainly seen in the picture and as indicated in Figure 2, serious corrosion had taken place forming deep grooves parallel and adjacent to the longitudinal seam. This was due to the fact that the tank was installed in a horizontal position with the seam on the bottom. If this tank had remained in use, even though the weld had been good, it is almost a foregone conclusion that it would have exploded before very long from weakness due to corrosion. Where provision is made for internal inspection, such dangerous conditions would most likely be detected and the tanks removed from service before failure.

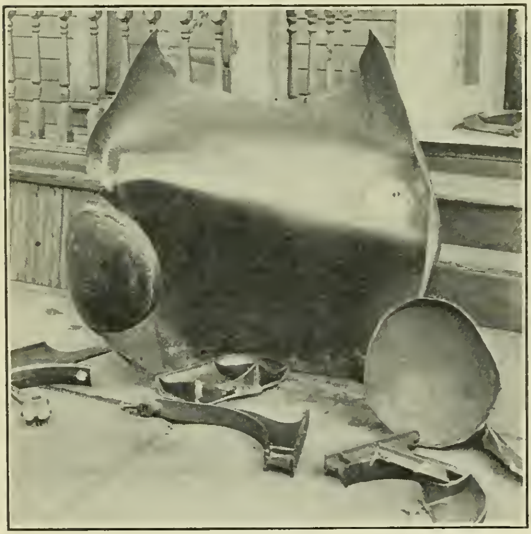


Fig. 3.

The old saying, "Where ignorance is bliss 'tis folly to be wise," doesn't apply in the case of Safety First. Get wise to the dangers about you. —*Walworth Kewanee Craftsman.*

Silicon Steel.

An Alloy Which Has Saved Millions of Tons of Coal.

WHEN Sir Robert A. Hadfield produced manganese steel, as recorded in [Research] Narrative 35*, he opened an area of vast possibilities, the field of alloy steels. He and other metallurgists pressed its exploration successfully. The world has profited greatly. Without these alloy steels, having remarkable properties, the progress of Mankind would have been retarded. There would be no automobiles, no airplanes. Many machines, structures and processes would have been impracticable. Hundreds of articles in daily use could not be made, or would cost much more.

Silicon steel, also invented by Sir Robert A. Hadfield, is a member of this family of alloys. First produced in quantity about 1906, it has in eighteen years saved through the electrical industry alone, more than enough money to build the Panama Canal. Reduction in waste of energy in electrical equipment is estimated to save now more than five million tons of coal a year. Many hundred thousand tons of silicon steel have been manufactured, mostly in thin plates for cores of electrical transformers.

Late in the 19th century, the best core material available was giving much trouble. Researchers were struggling with the problems. Hence the great importance of this invention, which was named " Low Hysteresis Steel " because of its remarkable magnetic properties. " Hysteresis " is a term used by engineers and scientists in several connections. In brief, magnetic hysteresis is the tendency of magnetic materials to persist in any magnetic state which already exists. It leads to loss of energy, which appears as heat, when the magnetic state of the object is changed. This and other losses are greatly reduced by silicon steel.

The first experimental transformer made by Hadfield with silicon steel in 1903, weighed 30 pounds. The first one made for service has been in successful use in Sheffield, England, since 1905. Its core weighs 830 pounds; if made of the best transformer iron then available, it would have weighed 1120 pounds and its electrical energy losses would have been more than one-third greater at the beginning. With silicon steel, the losses continued to decrease until they were much less than one-half what they would have been with the iron. With the iron core, the losses would have increased, at least for a time. Electrical manufacturers now regularly make transformers the larger ones of which each contain thousands of pounds of this steel.

---

*See THE LOCOMOTIVE, October 1923.

Few laymen know transformers by sight, although many have heard the name. Without transformers many wonderfully dependable electrical services would be far less satisfactory, or almost impracticable.

Silicon steel was not the result of a "hunch" or a "happy thought." Hadfield's invention of manganese steel was followed by the no less important invention by him of silicon steel. This attracted the attention of scientific workers and in 1888 a committee of the British Association invited him to assist in investigating the effect of high percentages of silicon. In September, 1889, he reported some of his discoveries to the Iron and Steel Institute of Great Britain. Only partial success had yet been achieved; as so often happens, one discovery led to others. In 1899, Sir William Barrett F.R.S. (then Professor of Experimental Physics at the Royal College of Science, Dublin) discovered its extraordinary magnetic and electrical characteristics; during the next three years Mr. W. Brown B. Sc. (an old pupil and assistant of the late Lord Kelvin), co-operated with Sir Robert Hadfield in further research. Joint papers by Barrett, Brown and Hadfield were read to the Royal Dublin Society and to the Institution of Electrical Engineers in 1899 and 1902.

Not, however, until several years later, after much experimental work had been done and many difficulties overcome, was Hadfield able to produce silicon steel as a marketable commodity.

Hadfield was granted a United States patent in 1903 for his invention, which consisted in heating steel containing 2½ to 4 per cent of silicon to about 900 to 1100 degrees Centigrade, cooling it, then reheating it to between 700 and 850 degrees Centigrade, and thereupon allowing it to cool slowly. Other improved methods followed and further patents were obtained.

Silicon steel, under low magnetizing forces, is far more magnetic than the best Swedish iron. Furthermore, it does not suffer from "ageing"; that is, its good magnetic properties do not deteriorate, as happened with the iron.

Silicon, the pure metalloid, has not been seen by many persons; but silica (silicon dioxide) is familiar to everybody in sand and quartz. Silica is the principal ingredient of glass; it is one of the most abundant substances of the outer crust of the earth. All iron and steel contain at least minute quantities of silicon.

Hadfield discovered how to combine large percentages of silicon with iron and make a special steel for much needed purposes and this steel when appropriately treated developed the desired magnetic and other physical qualities.

Thus success rewarded systematic research.

— *Research Narratives, Engineering Foundation.*

Automatic Appliances.

By Inspector E. H. Vaux, Pittsburgh Department.

ONE of the underlying causes of many accidents is the dependence placed on automatic appliances. The writer, while visiting a large plant where there are a number of water tube boilers, learned that an accident had occurred to one of the non-return valves on a boiler which was not in service. The eight-inch steam line to this boiler was piped with a non-return valve next to the boiler, then a bend of about 18 feet, and a gate valve at the header line.

The boiler had been taken out of service at 4 A. M. and, being fired by powdered coal, the fuel supply was shut off. The boiler was left with two gauges of water, depending on the non-return valve to close it off from the line. The attendant coming on duty at 7 A. M. noticed that the boiler was filled with water and decided to let a little out. He had just partly opened the blow off valve when the non-return valve exploded, resulting in considerable damage.

An investigation brought out the fact that the boiler had slowly filled with water, due probably to the failure of an automatic feed water regulator. Furthermore, the pressure within the boiler had risen until it equaled the pressure on the steam header, 150 lbs. This caused the non-return valve to reopen and let some of the water pass into the steam line. It was probably before very much had passed that the blow-off valve was opened. When the pressure within the boiler dropped, the non-return valve closed, and the water, in attempting to return, set up a water-hammer which broke the valve.

Automatic appliances are excellent things and usually operate properly, but implicit confidence should not be placed in them. In this case the average is 50-50,— the non-return valve did operate properly, much to its own grief, but the feed water regulator did not. The timely arrival of the attendant very likely averted a more serious accident such as would have resulted if the water had gone over to the engines and turbines.

In taking a boiler out of service, wait until the non-return valve closes automatically and then close it by hand, after which close the second valve, or the one on the header line, opening the drains between them.

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, JANUARY, 1925.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

THE increasingly wide use of the reinforced tube ligament in the construction of steam boilers has stimulated an interest in the manner of computing the efficiencies of such constructions. Very little has been published to date on this subject, although the closely allied but much older subject of the efficiences of riveted joints has been extensively treated. The article on page 131 is therefore timely.

In presenting this subject each mode of failure has been analyzed, the proper formula substituted in each case, the proper substitutions made in the formula, and so on step by step to the final solution. This method, it is hoped, will be particularly convenient to follow in individual study.

Obituary.

ASA B. Ecoff, former Chief Inspector of the St. Louis Department of The Hartford Steam Boiler Inspection & Insurance Company, died December 6, 1924, at his home in St. Louis.

Mr. Ecoff was born at Beaver County, Penna., in 1844. After several years experience as engineer on Ohio and Mississippi River boats, he came to the Company in 1887 as an inspector, later becoming Chief Inspector and serving in this capacity until 1900. He has been associated with the Company for thirty-seven years, and his death marks the passing of another of the pioneers active in the early successes of the Company.

Announcement.

THE steadily increasing business of the Company has brought with it a corresponding increase in its engineering activities, besides being augmented by the problems of the new mechanical lines underwritten by the Company.

Power plant insurance engineering is vastly different from what it was even a decade ago, and it requires more skill and study than ever before. Editor W. D. Halsey of THE LOCOMOTIVE has given much of his time during the past year in order to assist our Chief Engineer, and has thus created and grown into a position where he is of such value that we desire to continue his services in this direction, and he has been promoted to the position of Assistant to the Chief Engineer, and is relieved of all editorial duties except in an advisory capacity.

Mr. Halsey is a graduate in mechanical engineering of Swarthmore College, and has had practical experience in machine shop work and as a designing and maintenance engineer with the Sharples Separator Company and the Baldwin Locomotive Works. For five years he was professor of mechanical engineering at George Washington University. During the World War Mr. Halsey was connected with the National Advisory Committee for Aeronautics, engaged in design work of engines for aircraft and planning their engine research laboratory.

During the past year the work of editing this publication has been largely in the hands of Assistant Editor B. C. Cruickshanks, who now is appointed Editor of THE LOCOMOTIVE. Mr. Cruickshanks is a graduate of George Washington University where he later was for three years an instructor in mechanical engineering. Prior to this he was an Assistant Physicist at the U. S. Bureau of Standards.

CHARLES S. BLAKE,
President.

HARTFORD, CONN., JANUARY 1, 1925.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JANUARY 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
24	7	Section of heating boiler cracked			J. W. Cockrum Printing Co.	Printing Office	Oakland City, Ind.
25		Section of heating boiler cracked			Robert E. Miller	Stores, Billiards & Bowling	Uniontown, Pa.
26		Eight sections heating boiler cracked			Brenholts Realty Co.	Realtors	Columbus, O.
27		Two sections heating boiler cracked			Ivan Allen	Office Bldg.	Atlanta, Ga.
28		Fourteen sections heating boiler cracked			County of Tompkins	Court House	Ithaca, N. Y.
29		Three sections heating boiler cracked			Yough Trust Co.	Bank & Office Bldg.	Connellsville, Pa.
30		Two headers cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
31		Ammonia pipe gasket blew out			Oswego Netherland Co., Inc.	Refrigerating Plant	Oswego, N. Y.
32	8	Hot water heated exploded		3	Charles Stopkey	Residence	Cincinnati, O.
33		Ammonia tank exploded		6	Billiams Ice Cream Co.	Ice Cream Plant	Indianapolis, Ind.
34		Valve ruptured		3	Brooklyn-Manhattan Transit Cpn.	Power Plant	Brooklyn, N. Y.
35		Boiler ruptured and tubes collapsed			Jacksonville Gas Co.	Gas Plant	Jacksonville, Fla.
36		Section of heating boiler cracked			School District No. 1	School	Three Rivers, Mich
37		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
38	9	Boiler ruptured			Public School	School	Oxford, O.
39		Tube ruptured			Proctor & Gamble Mfg. Co.	Soap Products	Dallas, Texas
40		Two sections heating boiler cracked			Sterling Engine Co.	Engine Builders	Buffalo, N. Y.
41		Cast iron manhole cover cracked			Allerdice Hide & Tallow Co.	Rendering Plant	Saratoga Springs, N. Y.
42	10	Section of heating boiler cracked			St. Roch's Catholic Church	Church	St. Louis, Mo.
43		Section of heating boiler cracked			Public Baking Co., Inc.	Bakery	New York, N. Y.
44		Boiler bulged and ruptured			Miwogco Mineral Well & Sanitarium Co.	Sanitarium	Milan, Ind.
45	11	Section of heating boiler cracked			Plaza Hotel Co.	Hotel	Omaha, Neb.
46		Tube pulled out of superheater			Public Service Co. of No. Ill.	Public Utilities	Blue Island, Ill.
47	12	Tube ruptured		1	Northwestern Barbed Wire Co.	Wire Factory	Sterling, Ill.
48	13	Boiler exploded		2	D. J. Smith	Residence	Roanoke, Va.

49	13	Two sections heating boiler cracked			Meletio Sea Food Co.	Market	St. Louis, Mo.
50	15	Manifold of heating boiler cracked			Home for Aged People	Home	Fall River, Mass.
51		Section of heating boiler cracked			Town of Ludlow	School	Ludlow, Mass.
52		Expansion joint failed			Wyoming Worsted Mill	Woolen Mill	Tunkhannock, Pa.
53		Crown sheet failed			Southern Carbon Co.	Gasoline Plant	Monroe, La.
54		Boiler of locomotive exploded	2		A. T. & Santa Fe R. R. Co.	Railroad	Lariat, Tex.
55	16	Tube failed			Wausau Sulphite Fiber Co.	Pulp Mill	Mosinee, Wis.
56		Boiler of locomotive exploded	2	1	Gulf Coast Lines	Railroad	Westbury, Tex.
57	17	Boiler exploded		3	Orth Well, Warren Lease	Oil Well	Wichita Falls, Tex.
58		Two sections heating boiler cracked			L. Janopoulus & F. Pappas	Stores	Newton Centre, Mass.
59	18	Section of heating boiler cracked			Lowe's Inc.	Theatre	New York, N. Y.
60		Four sections heating boiler cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
61	19	Two sections heating boiler cracked			Estate of Harriet Fellner	Apartment House	Roxbury, Mass.
62		Five sections heating boiler cracked			Sowers Mfg. Co.	Foundry	Buffalo, N. Y.
63		Boiler of locomotive exploded		3	N. Y., Ch. & St. L. R. R. Co.	Railroad	Valparaiso, Ind.
64		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
65	20	Boiler bulged and ruptured			Germain Bros.	Factory	Saginaw, Mich.
66	21	Section of heating boiler cracked			Alcazar Co.	Apartment House	Cleveland Hgts., O.
67		Two sections heating boiler cracked			Town of Covington	High School	Covington, Tenn.
68		Four sections of heating boiler cracked			Lukenheimer Co.	Brass Goods Facty.	Carthage, Ohio
69		Boiler exploded			Rockford Gas Light & Coke Co.	Gas Plant	Rockford, Ill.
70		Tube ruptured			Old Ben Coal Corpn.	Coal Mine	Westfrankfort, Ill.
71		Steam main ruptured			Footer's Dye Works, Inc.	Dye Works	Cumberland, Md.
72	22	Section of heating boiler cracked			American Sea Grass Co.	Bedding Material Factory	Brooklyn, N. Y.
73		Crown sheet of locomotive failed			Andron Logging Co.	Logging	Darrington, Wash.
74	23	Crown sheet failed		1	N. Y. C. R. R. Co.	Pumping Station	Lydick, Ind.
75		Boiler of locomotive exploded	3		Pittsburgh & Lake Erie R R. Co.	Railroad	Aliquippa, Pa.
79		Two sections heating boiler cracked			Commissioners of Union County	County Home	Union, S. C.
77		Four sections heating boiler cracked			Fiat Repairs Co.	Auto Repair Plant	New York, N. Y.
78		Section of heating boiler cracked			Weavers Progressive Assn.	Business Block	Fall River, Mass.
79		Boiler bulged and ruptured			Forest Products Chem. Co.	Chemical Plant	Memphis, Tenn.
80		Furnace flue of boiler collapsed			Caskey Cleaning Co.	Cleaning & Dyeing	Columbus, O.
81	24	Two sections heating boiler cracked			The Euclid-Hamilton Market	Market & Stores	Detroit, Mich.
82		Boiler of locomotive exploded			T. R. Miller Mill Co., Inc.	Lumber Mill	Brewton, Ala.
83	25	Kier cover blew off		5	Meridian Fibre Co.	Fibre Mill	Meridian, Miss.
84		Boiler exploded		4	J. K. Hughes Developing Co.	Oil Well	Corsicana, Tex.
85		Section of heating boiler cracked			Garcia Realty Co., Inc.	Apartment House	New York, N. Y.

MONTH OF JANUARY, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
86	25	Section of heating boiler cracked			Buckner School District	School	Buckner, Ill.
87	26	Section of heating boiler cracked			Church of Our Lady of Mercy	Church	New York City
88		Four sections heating boiler cracked			Harvard Realty Co.	Business Block	Framingham, Mass.
89		Crown sheet of locomotive failed			Narva Coal Co.	Strip Mine	Steubenville, O.
90	27	Four sections heating boiler cracked			First Presbyterian Church	Church	Leechburg, Pa.
91		Sections of heating boilers (3) cracked			Board of Freeholders	Court House	Morristown, N. J.
92		Two sections and manifold of heating boiler cracked			Westminster School, Inc.	School	Simsbury, Conn.
93		Boiler ruptured			Weissing Bldg.		Hazelton, Pa.
94	28	Section of heating boiler cracked			Beckley Baking Co.	Bakery	Beckley, W. Va.
95		Two sections heating boiler cracked			Mansfield Sheet & Tin Plate Co.	Office Bldg.	Mansfield, O.
96		Four sections heating boiler cracked			Robt. Findlay Mfg. Co.	Offices & Stores	New York, N. Y.
97		Two sections heating boiler cracked			Feinberg Bros.	Business Block	Hartford, Conn.
98		Tube ruptured			Thomas Devlin Mfg. Co.	Pipe Fittings Plant	Burlington, N. J.
99		Boiler exploded			17 Middagh St.	Apartment House	Bkn. Hgts., N. Y.
100		Boiler exploded		1	Police Dept.	Police Station	Mobile, Ala.
101	29	Section of heating boiler cracked			Connellsville Macaroni Co.	Macaroni Factory	Connellsville, Pa.
102		Section of heating boiler cracked			L. J. Marks & E. I. Kaufmann	Mercantile Bldg.	Columbus, O.
103	30	Boiler of locomotive exploded	3	12	Pennsylvania R. R. Co.	Railroad	St. Georges, Pa.
104		Expansion joint packing blew out		1	Western Reserve Cons'd Milk Co.	Con'sd. Milk Plant	Yorktown, Ind.
105		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.

MONTH OF FEBRUARY, 1924.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
106	1	Section of heating boiler cracked			Chas. C. Griswold	Apartment House	Minneapolis, Minn.
107		Two sections heating boiler cracked			Borris Bernstein	Apartment House	Brooklyn, N. Y.
108		Two sections heating boiler cracked			Beatrice Iron	Rooming House	Brooklyn, N. Y.
109	2	Two sections heating boiler cracked			University of Vermont	University	Burlington, Vt.
110	3	Two sections heating boiler cracked			Tarrytown National Bank	Bank & Office Bldg.	Tarrytown, N. Y.
111	4	Section of heating boiler cracked			Shredded Wheat Co.	Bakery	Niagara Falls, N.Y.
112		Two sections heating boiler cracked			R. C. Church of the Ascension	Gymnasium	New York, N. Y.

113		Crown sheet of locomotive failed		2	Andrews Mfg. Co.	Lumbering	Andrews, N. C.
114		Blow-off pipe ruptured			House of the Good Shepherd	Convent & Laundry	Omaha, Neb.
115	5	Blow-off pipe fitting failed		1	Morehead Cotton Mills	Cotton Mill	Spray, N. C.
116		Boiler exploded	5		Crider Rolling Mill	Flour Mill	Crider, Ky.
117		Three sections heating boiler cracked			Morris Cohn	Garage	New Britain, Ct.
118		Two sections heating boiler cracked			Ulster County Savings Bank	Office Bldg.	Kingston, N. Y.
119		Section of heating boiler cracked			Conron Bros. Co. Inc.	Stores & Lofts	New York, N. Y.
120		Eight sections heating boiler cracked			Conron Bros. Co. Inc.	Stores & Lofts	New York, N. Y.
121		Section of heating boiler cracked			34 West 32nd St. Co.	Stores & Loft	New York, N. Y.
122	6	Four sections heating boiler cracked			V. La Rosa & Sons	Manufacturing	Brooklyn, N. Y.
123		Section of heating boiler cracked			P. & L. Realty Co.	Stores & Apts.	Brooklyn, N. Y.
124	7	Eight headers cracked			Mary Goelet	Miscellaneous	New York, N. Y.
125		Boiler exploded	1		N. T. Clark Farm	Saw Mill	Inman, N. C.
126		Section of heating boiler cracked			Filbeck Hotel	Hotel	Terre Haute, Ind.
127		Seven sections heating boiler cracked			H. P. & E. H. Dygert	Theatre	E. Rochester, N. Y.
128		Two sections heating boiler cracked			Bd. of Public Education	School	Pittsburgh, Pa.
129		Five sections heating boiler exploded			Bd. of Public Education	School	Pittsburgh, Pa.
130		Section of heating boiler cracked			The Mac Gregor Garage	Garage	Waltham, Mass.
131	9	Tube failed			Amicable Life Ins. Co.	Office Building	Waco Texas.
132	10	Five tubes pulled out of drum			By-Products Coke Corp.	Coke Oven Plant	Chicago, Ill.
133	11	Section of heating boiler cracked			Borris Bernstein	Apartment House	Brooklyn, N. Y.
134		Boiler bulged and ruptured			City of Obion	Light & Water Pla	Obion, Tenn.
135		Main stop valve ruptured		2	Bigelow-Hartford Carpet Co.	Carpet Factory	Clinton, Mass.
136		Injector ruptured		1	Shaffer Coal Mine	Coal Mine	Atwater, Ohio.
137	12	Section of heating boiler exploded			Cushman Realty Co.	Apartment House	New York, N. Y.
138	13	Boiler of locomotive exploded	2		A. T. & S. F. R. R. Co.	Railroad	Lariat, Tex.
139		Section of heating boiler cracked			Ashland Realty Co.	Apartment House	Buffalo, N. Y.
140		Section of heating boiler cracked			Loew's Inc.	Theatre	N. Rochelle, N. Y.
141		Section of heating boiler cracked			T. E. Braniff	Apartment House	Oklahoma City, Okla.
142	14	Section of heating boiler cracked			Board of Education	School	Ft. Recovery, Ohio.
143		Tube ruptured			Hanna Furnace Co.	Blast Furnace	Buffalo, N. Y.
144		Tube ruptured			Pittsburgh Crucible Steel Co.	Steel Plant	Midland, Pa.
145	15	Tube ruptured		1	N. Y., N. H. & H. R. R. Co.	Railroad	Boston, Mass.
146		Head of mud drum failed		1	National Tube Co.	Tube Works	Benwood, W. Va.
147		Two sections heating boiler cracked			Calo Theatre	Theatre	Chicago, Ill.
148	16	Section of heating boiler cracked			Noble & Westbrook Mfg. Co.	Stamp & Dye Wks.	East Hartford, Ct.
149		Hot water boiler exploded		1	Penna. R. R. Co.	Round House	Mingo Junction, O.
150	17	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.

MONTH OF FEBRUARY, 1924 (continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
151	17	Twelve headers cracked			National Asbestos Co.	Asbestos Paper Mil	Jersey City, N. J.
152		Three tubes ruptured			Rensselaer Polytechnic Inst.	College	Troy, N. Y.
153	18	Section of heating boiler cracked			O'Bryan Bros.	Factory	Nashville, Tenn.
154		Section of heating boiler cracked			St. Catherine's School	School	Dubois, Pa.
155		Fitting on circulating pipe cracked			Calhoun Commercial Club	Club House	Minneapolis, Minn.
156		Boiler ruptured			Margaret Little	Apartment House	S. Francisco, Calif.
157		Accident to return main of heating boiler		1	Buffalo Envelope Co.	Envelope Factory	Buffalo, N. Y.
158	19	Eleven headers cracked			General Motors Corpn.	Motor Research	Dayton, Ohio.
159		Two sections heating boiler cracked			University of Pittsburgh	University	Pittsburgh, Pa.
160		Boiler exploded		1	J. B. Parker	Saw Mill	Winona, Ala.
161	20	Boiler exploded	1		Northside School	Public School	Grayville, Ind.
162		Five sections heating boiler cracked			St. Ignatius Church	Church	Cleveland, Ohio.
163	21	Fifteen sections heating boiler cracked			Nordyke & Marmon Co.	Automobile Fact'y	Indianapolis, Ind.
164		Boiler of locomotive exploded			N. Y. C. R. R. Co.	Railroad	Enos, Ind.
165		Tube ruptured	2	3	Washington Gas & Elec. Co.	Power Plant	Washington C. H., Ohio.
166		Tube ruptured	1	1	Verigood Silk Throwing Co.	Silk Mill	West Pittston, Pa.
167	22	Three tubes ruptured			Climax Cleaner Co.		Cleveland, Ohio.
168		Four sections heating boiler cracked			The Pelham Health Inn, Inc.	Hotel & Restaurant	New York, N Y.
169		Two sections heating boiler cracked			The Pelham Health Inn, Inc.	Hotel & Restaurant	New York, N Y.
170		Header cracked			Alex Smith & Sons Carpet Co.	Carpet Mill	Yonkers, N. Y.
171		Boiler exploded		4	Nathaniel Baldwin, Inc.	Radio Ractory	Chicago, Ill.
172		Boiler of locomotive exploded	3		M. K. & T. R. R. Co.	Railroad	Hominy, Okla.
173	23	Section of heating boiler cracked			Hotel Gladstone	Hotel	Dorchester, Mass.
174		Five sections heating boiler cracked			John R. Webb		Atlanta, Ga.
175	24	Tube ruptured			Pittsburgh & Lake Erie R. R. Co.	Railroad	Pittsburgh, Pa.
176		Manifolds of heating boiler cracked			John W. Cutlar	Apartment House	Des Moines, Ia.
177	25	Five sections heating boiler cracked			J. R. Porter, County Judge	Court House	San Marcos, Texas.
178	26	Vacuum pan collapsed			Harding Cream Co.	Creamery	Omaha, Neb.
179		Valve ruptured			Public Service Corp. of N. J.	Gas Works	Hackensack, N. J.
180		Four sections heating boiler cracked			Sowers Mfg. Co.	Foundry	Buffalo, N. Y.
181	27	Two sections heating boiler cracked			The Westminster School	School	Simsbury, Conn.
182		Two sections heating boiler cracked			Loew's Inc.	Theatre	New York, N. Y.

183	27	Boiler exploded			Ames Shovel & Tool Co.	Shovel Works	No. Anderson, Ind.
184	28	Boiler of locomotive exploded	3		Southern Pacific R. R. Co.	Railroad	Noonan, Texas.
185		Boiler bulged and ruptured			Nickey Brothers	Lumber Mill	Memphis, Tenn.
186		Tube ruptured			Frost-Johnson Lumber Co.	Saw Mill	Shreveport, La.
187		Tube ruptured			Port Arthur Light & Power Co.	Power Plant	Port Arthur, Tex.
188	29	Paper machine drying cylinder exploded	2	8	North Star Strawboard Mills	Strawboard Mill	Quincy, Ill.
189		Main steam line exploded			Kansas City Star	Publishers	Kansas City, Mo.
190		Feed pipe pulled out			Frankfort Heating Company	Heating Plant	Frankfort, Ind.

MONTH OF MARCH, 1924.

191	1	Section of heating boiler cracked			Hadspar Realty Co.	Loft Bldg.	New York, N. Y.
192		Seven sections heating boiler cracked			Bartlett School	School	New Britain, Conn.
193		Section of heating boiler exploded				Hat Factory	Des Moines, Iowa.
194	2	Cylinder exploded	1	1	American Woodworking Mchy. Co.	Machinery	Rochester, N. Y.
195		Main stop valve ruptured			Town of Rowlesburg	Pumping Station	Rowlesburg, W. Va
196	3	Tube ruptured			United Electric Light Co.	Power Plant	Springfield, Mass.
197		Boiler exploded				Barber Shop	Tombstone, Ariz.
198	4	Boiler exploded		3	Chas. F. Lasch	Bakery	Cleveland, Ohio.
199	5	Tube ruptured			Wilson Syndicate Trust	Office Building	Dallas, Tex.
200	6	Six sections heating boiler cracked			L. Ravin & S. R. Gordon	Mercantile Bldg.	Lynn, Mass.
201		Boiler of locomotive exploded	2		New York Central R. R. Co.	Railroad	Starbrick, Pa.
202	7	Boiler bulged and ruptured			R. Scheffler	Green House	Wheaton, Ill.
203	8	Two sections heating boiler cracked			St. James Hotel	Hotel	Knoxville, Tenn.
204		Section of heating boiler cracked			Diamond Power Specialty Corp.	Steam Specialties	Detroit, Mich.
205		Four sections heating boiler cracked			Meyer & Mendelsohn, Inc.	Tobacco Wareh'se	New York, N. Y.
206	9	Section of heating boiler cracked			Outlet Millinery Co.	Dwelling House	New Haven, Conn.
207		Boiler bulged and ruptured			Bastrop Paper & Pulp Co.	Paper Mill	Bastrop, La.
208		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
209	10	Tube ruptured			Morton Salt Co.	Salt Works	Port Huron, Mich.
210		Section of heating boiler cracked			J. C. Kerrigan	Mercantile Bldg.	New Haven, Conn.
211		Four sections heating boiler cracked			Indep. Consolidated School Dist.	School	Johnstown Sta., Ia.
212	11	Two sections heating boiler cracked			Borders & Tutwiler	Hotel	Birmingham, Ala.
213		Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
214		Tube ruptured			Rancho Sespe	Pumping Plant	Sespe, Calif.
215	12	Blow-off pipe fitting ruptured		1	N. Y., N. H. & H. R. R. Co.	Railroad	Worcester, Mass
216		Boilers (2) ruptured				School	Milford, Mich.

MONTH OF MARCH, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
217	13	Boiler exploded		3	Lawson Maynard	Saw Mill	Maynard's Mill Ga.
218		Tube ruptured			Edw. G. Budd Mfg. Co.	Automobile Bodies	Philadelphia. Pa.
229		Section of heating boiler cracked			W. A. Brightwell	Apartment House	Atlanta, Ga.
220		Five sections heating boiler cracked			J. J. Owens	Shoe Factory	Haverhill, Mass.
221	14	Twelve sections heating boiler cracked			Englander Spring Bed Co.	Bed Factory	Brooklyn, N. Y.
222		Five sections heating boiler cracked			Plaza Hotel Company	Hotel	Omaha, Neb.
223		Tubes pulled out of drum			Denver Tramway	Street Railway	Denver, Colo.
224		Tube ruptured			New South Oil Mill	Oil Mill	Helena, Ark.
225		Boiler exploded			J. D. Pope	Saw Mill	Alamo, Ga.
226	15	Vulcanizer exploded		1	E. F. Wilkins		S. Francisco, Calif.
227		Two sections heating boiler cracked			Ostex Realty Co.	Apartment House	New York, N. Y.
228		Two sections heating boiler cracked			Dartmouth Stuart Corp.	Theatre	Boston, Mass.
229		Section of heating boiler cracked			Garford Motor Truck Co.	Garage	Lima, Ohio.
230	16	Section of heating boiler cracked			R. J. Goodman	Stores and Offices	Hartford, Conn.
231		Section of heating boiler cracked			J. J. Prindeville	Garage	Framingham, Mass
232		Tube ruptured			C. H. Wheeler Mfg. Co.	Machinery	Philadelphia, Pa.
233	17	Tube ruptured			Nekoosa Edwards Paper Co.	Sulphate Pulp Mill	Port Edwards, Wis
234		Section of heating boiler cracked			Loew's Inc.	Theatre	New York, N. Y.
235	18	Two sections heating boiler cracked			President Suspender Co.	Suspender Factory	Shirley, Mass.
236		Four sections heating boiler cracked			St. Bernard's Society	Church	Rockville, Conn.
237	19	Hot water heating boiler exploded		1	Hamilton Christian Church	Church	St. Louis, Mo.
238	20	Boiler ruptured				School	Ubly, Mich.
239		Blow-off pipe fitting failed			Imperial Laundry Co.	Laundry	Buffalo, N. Y.
240		Section of heating boiler cracked			Air Reduction Company	Chemical Plant	Cleveland, Ohio.
241	21	Five sections heating boiler cracked			Wallace Thomson Hospital	Hospital	Union, S. C.
242		Two sections heating boiler cracked			City of Utica	School	Utica, N. Y.
243		Three sections heating boiler cracked			Robert C. Miller	Store Bldg.	Uniontown, Pa.
244		Tube ruptured			Consumers Power Co.	Power Plant	Gd. Rapids, Mich.
245	22	Tube ruptured			St. Vincent's Academy	School	Shreveport, La.
246	24	Tube ruptured			Nekoosa Edwards Paper Co.	Sulphate Pulp Mill	Port Edwards, Wis
247		Crown sheet failed			White Oil Corporation	Refinery and pumping Plant	Houston, Texas.
248		Section of heating boiler cracked			Edgar T. Ward Sons Co.	Warehouse	So. Boston, Mass.

249	24	Autogenously welded overall drier exploded		2	Piedmont Laundry	Laundry	Spartansburg, S. C.
250	25	Boiler exploded	1			Oil Well	Electra, Texas.
251		Fitting on blow-off line failed		1	N. O. Gas Light Co.	Gas Plant	Algiers, La.
252		Five tubes pulled out of drum			Utah Power & Light Co.	Power Plant	Salt Lake City, U.
253	27	Tube pulled out of drum	1		Crucible Steel Co.	Steel Plant	New York, N. Y.
254		Five sections heating boiler cracked			Ramsey Realty Corp.	Apartment House	New York, N. Y.
255	29	Six sections heating boiler cracked			Princeton Hotel Co.	Hotel and Apts.	Boston, Mass.
256	30	Steam main failed			City of Dothan	Water & Light Plt.	Dothan, Ala.
257		Boiler exploded	1	1	Gulf Refining Co.	Oil Well	El Dorado, Ark.
258		Blow-off pipe failed		1	City of Occonomowoc	Water Works	Occonomowoc, Wis
259	31	Section of heating boiler cracked			Board of Education	School	Bridgeport, Ct.
260		Five headers cracked			Bender Hotel Operating Co.	Hotel	Houston, Tex.

MONTH OF APRIL, 1924.

261	1	Three sections heating boiler cracked			Town of Sharon	Town Hall	Sharon, Mass.
262		Tube pulled out of drum			Hodenpyle, Hardy Co.	Power Plant	Springfield, O.
263		Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
264		Boiler exploded		2	Spelbring Lease	Pump House	Westfield, Ill.
265	4	Section of heating boiler cracked			University of Vermont	University	Burlington, Vt.
266	6	Section of heating boiler cracked			F. W. & M. H. Gumble	Business Block	Springfield, Mass.
267		Two sections of heating boiler cracked			E. J. T. & H. W. Orr	Garage	Newtonville, Mass.
268	8	Tube ruptured			Granfield Lt. & Ice Co.	Ice & Power Plt.	Granfield, Okla.
269		Fitting on ammonia line ruptured			Waycross Ice & Cold Storage Co.	Refrigerating Plt.	Waycross, Ga.
270	9	Section of heating boiler cracked			Thos. R. Delaney	Apts. & Stores	Hartford, Conn.
271		Tube pulled out of drum			Hodenpyle, Hardy Co.	Power Plant	Springfield, O.
272		Two headers cracked			Zinsser & Co.	Chemical Plt.	Hastings-on-Hudson, N. Y.
273		Boiler exploded	1	2	Ellis Saw Mill	Saw Mill	Marshall, Ark.
274	10	Boiler exploded		3	J. E. Kay	Farm	Mondamin, Iowa.
275	11	Blow-off pipe failed		2	Consolidated Paper Co.	Paper Mill	Monroe, Mich.
276		Tube sheet failed			Caton & Curott	Laundry	Hastings, Neb.
277		Throttle valve ruptured			Midvale Company	Steel Plant	Philadelphia, Pa.
278		Section of heating boiler cracked			S. & L. Suehter	Apt. House	Chicago, Ill.
279	12	Eight headers cracked			Chicago Surface Lines	Public Utility	Chicago, Ill.
280	14	Two sections heating boiler cracked			Dora Ungar	Glass Grinding	Brooklyn, N. Y.
281		Tube ruptured		1	Carnegie Steel Co.	Steel Plant	Pittsburgh, Pa.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1923

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks		$507,869.87
Real Estate		255,000.00
Mortgage and collateral loans		1,818,750.00
Bonds and stocks		8,414,500.82
Premiums in course of collection		1,029,559.34
Interest Accrued		140,348.10
Total assets		$12,166,028.13

LIABILITIES

Reserve for unearned premiums		$5,530,427.71
Reserve for losses		318,407.05
Reserve for taxes and other contingencies		457,030.70
Capital stock	$2,500,000.00	
Surplus over all liabilities	3,360,162.67	
Surplus to Policyholders, ...		**$5,860,162.67**
Total liabilities		$12,166,028.13

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Chairman, Board of Trustees, United States Security Trust Co., Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, President, United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President, Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Vice-President, The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President and Treasurer, The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President, The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President, The Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.
WM. R. C. CORSON, Vice-President, The Hartford Steam Boiler Inspection and Insurance Co.
SAMUEL M. STONE, President, Colts Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, President, The Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866 THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. FRANCIS, Manager. C. R. SUMMERS, Chief Inspector.
BALTIMORE, Md., 13-14-15 Abel Bldg.	LAWFORD & McKIM, General Agents. JAMES G. REID, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	WARD I. CORNELL, Manager. W. A. BAYLISS, Chief Inspector.
BRIDGEPORT, Conn., 404-405 City Savings Bank Bldg.	W. G. LINEBURGH & SON, General Agents. A. E. BONNET, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'l'v'd	P. M. MURRAY, Manager. J. P. MORRISON, Chief Inspector. J. T. COLEMAN, Ass't Chief Inspector. C. W. ZIMMER, Ass't Chief Inspector.
CINCINNATI, Ohio First National Bank Bldg.	W. E. GLEASON, Manager. WALTER GERNER, Chief Inspector.
CLEVELAND, Ohio Leader Bldg.	A. PAUL GRAHAM, Manager L. T. GREGG, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J. H. CHESNUTT. Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. KENYON, General Agent. A. E. BONNET, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. BURWELL, Mgr. and Chief Inspector. E. UNSWORTH, Ass't Chief Inspector.
NEW YORK, N. Y. 80 Maiden Lane	C. C. GARDINER, Manager. E. MASON PARRY, Chief Inspector. R. P. GUY, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. WICKHAM, Manager. S. B. ADAMS, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrott Bldg.	GEO. S. REYNOLDS, Manager. J. A. SNYDER, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	BATES, LIVELY & PEARSON, Gen'l Agents. C. B. PADDOCK, Chief Inspector.
SEATTLE, Wash., 415 Dexter Horton Bldg.	C. B. PADDOCK, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. MANN & CO., General Agents. J. B. WARNER, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. ASHCROFT, Manager. EUGENE WEBB, Chief Inspector.
TORONTO, Canada, Federal Bldg.	H. N. ROBERTS, President, The Boiler Inspection and Insurance Company of Canada.

CARNEGIE LIBRARY
JUL 31 1925
OF PITTSBURGH, PENNA

ELECTRICAL MACHINERY INSURANCE

Inspections made by HARTFORD ELECTRICAL INSPECTORS are of the same thorough character as those that have made HARTFORD BOILER INSPECTIONS the standard for comparison.

A Hartford Electrical Policy

PROTECTS against loss due to
- Burnouts
- Short Circuits
- Lightning
- Mechanical Breakage
- Explosion from overspeed
- Etc.

INSURES
- Rotating Machinery
- Transformers
- Switchboards
- Etc.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER INSPECTION and INSURANCE CO.

HARTFORD CONNECTICUT

"The *oldest* in the Country, the *largest* in the world"

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

Vol. XXXV. HARTFORD, CONN., APRIL, 1925. No. 6.

COPYRIGHT, 1925, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Digester Explosion at Lock Haven, Pa.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Digester Explosion at Lock Haven, Pa.

A DISASTROUS explosion occurred September 22, 1924, at the plant of the New York & Pennsylvania Company, Lock Haven, Pa. One of the sulphate digesters exploded, killing three employees and injuring four others, and resulted in a property loss of $150,000. There is no picture available showing all of the wrecked area, but the view on the cover and also Fig. 1, both taken from within the digester room, show a portion of the wreckage.

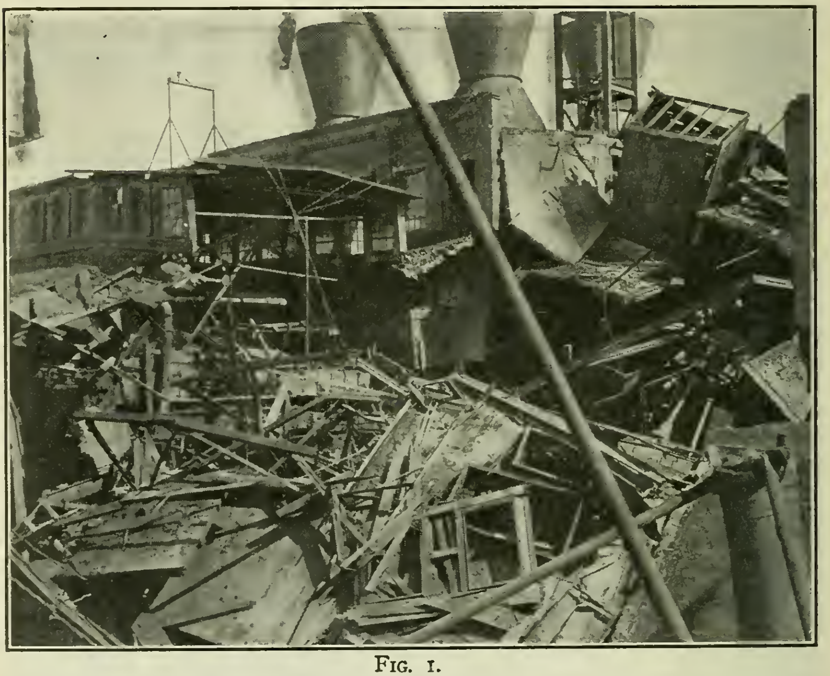


FIG. 1.

The digester that exploded was No. 7 of a battery of twelve arranged as shown in the plan in Fig. 2. All of them were either blown from their foundations and lying down or else in such dangerous positions that they had to be removed. The digester building was a complete wreck and parts of adjacent buildings were damaged. In accidents such as this one, flying pieces of wreckage usually do considerable damage at places quite remote from the scene. In this instance, however, the damage, though severe, was restricted to the comparatively small area in the immediate vicinity of the digester building. A heavy reinforced concrete charging floor near the top of the vessel undoubtedly exerted a smothering effect.

A sulphate digester is a vessel used in the pulp and paper industry for the manufacture of wood pulp by the sulphate process. It consists of a vertical steel shell with an opening at the top through which a suitable charge of wood chips is fed. The requisite quantity of sulphate liquor (sodium sulphide and caustic soda) is then added, the vessel sealed up, and live steam turned in. The pressure gradually mounts until the maximum pressure is reached which is maintained during the cooking process. The vessel is then emptied by blowing the contents into a tank. The blowing out of the material under full pressure is considered an essential part of the process in that the chips, though softened by the cooking, are not broken up until thus blown out. The total time required to load, cook and blow down one charge is approximately four hours. As there were five cooks each day, the pressure within the vessel ranged from zero to a maximum (125 lbs.) and returned five times a day.

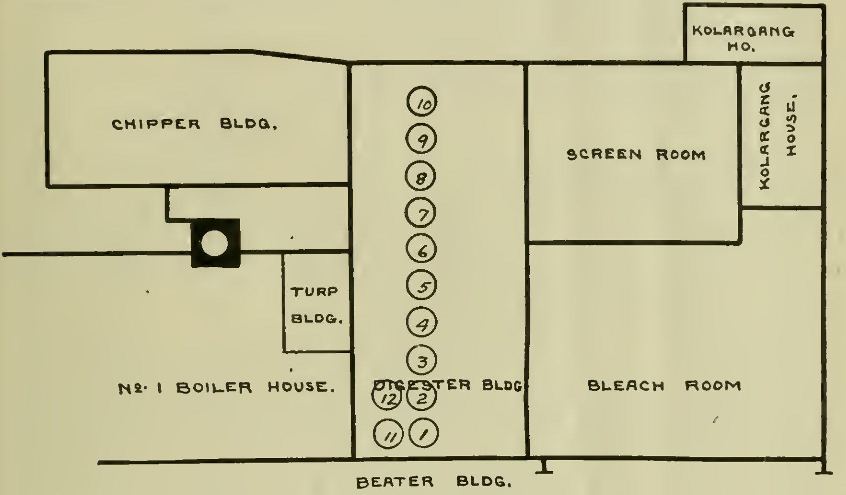


FIG. 2.

The digester that exploded was 72 inches in diameter by 25 ft. high, and was constructed of 1/2 inch steel plate. It was of welded construction throughout, there being no riveted joints. The charging opening at the top was 17 inches in diameter and the blow-off pipe 6 inches. The entire vessel was covered with heat insulating material. Apparently no unusual operating conditions existed at the time of the explosion. The cooking process was progressing as usual when the digester let go without warning.

Examination of the wrecked vessel disclosed a separation into four parts as shown in Fig. 3. The bottom course and head were torn off at the first girth seam. The middle and top courses were torn across longitudinally and opened out flat. The top head blew out and in addition the manhole ring in the top head also went out by itself. As will be noted, the break seems to have followed the welds to a considerable extent and, from the character of the rupture, it would appear as if the explosion resulted from the weakening of an imperfectly welded joint by the gradual thinning of the vessel.

Because of the peculiar nature of the break there is some difference of opinion as to just where the initial failure occurred, that is, whether the upper head failed first or the lower portion of the shell. The indications point more strongly toward the latter. For about one-third of the distance around the lower seam there appears to have been very little of the metal actually joined in the weld and the two pieces of metal slipped apart at the scarfed joint with very little tearing. The only portions of the defective part of this joint that appear to have been thoroughly welded are at the edges of the scarf, as indicated by the line of rupture in Fig. 4A. Furthermore, in places the portion of the joint between *a* and *b* showed a polished appearance as if a small amount of movement had been taking place there for a considerable period of time. The wasting away of the interior of the digester removed part of the metal from the sound portion of the joint and thus seriously weakened it. Additional evidence that the initial break occurred here is given by the fact that the side of the shell opposite to the rupture caved in, apparently as the result of the

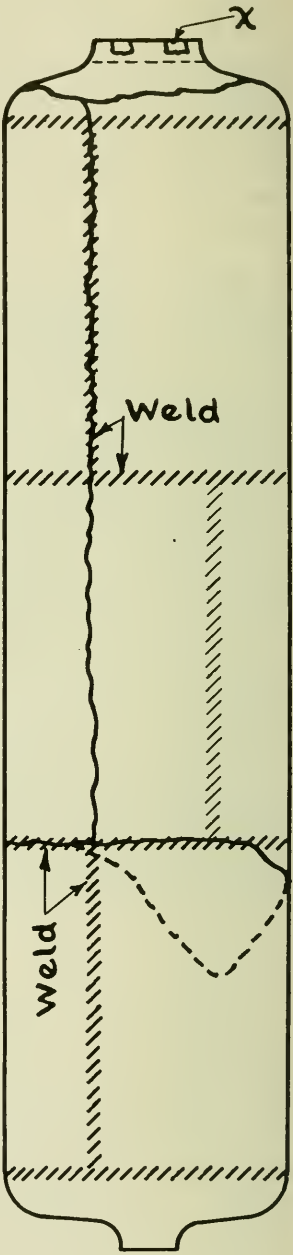


FIG. 3.

bending back of the lower course at this seam. Also the failure of the explosion to be widespread in effect, as previously mentioned, would indicate the initial failure to have been near the bottom of the vessel.

From the lower girth seam the line of rupture passed through the solid plate across the middle ring or course and continued up along the longitudinal weld of the top course. It is interesting to note that although the tear followed the seam in this top course, the joint appeared sound, as the failure was through the metal and not by separation of the weld. This is indicated in Fig. 4B. The line of rupture then continued into the upper head and circled around it, completely severing the head from the top course.

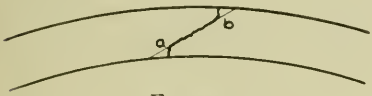


Fig. 4A

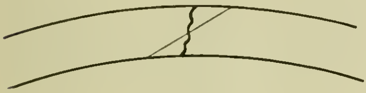


Fig. 4B .

The ripping out of the manhole ring in the top head was an entirely separate tear from the other lines of rupture, not connecting with them at any point. This ring was set inside, flush with the top of the shell and welded to it, as indicated in Fig. 4C. Studbolts projected for attaching the cover. When this ring blew out it separated cleanly from the shell for three-quarters of the circumference. At five different places, however, the welding for the manhole ring appears to have been sound, for at these places portions of the head plate were torn out and remained adhering to the ring, as shown at x, Fig. 3. The total length of these pieces of shell is 33½ inches or almost exactly one-quarter of the circumference.

As a result of this accident it has been found that sulphate digesters are subject to a gradual wasting away of the shell. Whether this thinning action is due to corrosion or erosion is not clear, but it takes place so gradually and so uniformly over the whole interior of the vessel that it generally leaves no visible evidence.

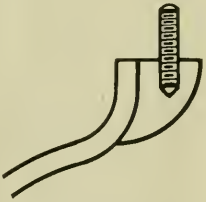


Fig. 4C

This accident brings out very forcibly the advantages of the indemnity feature of a boiler insurance policy. The equipment at this plant receives the best of care and no efforts are spared to keep it in an efficient and safe operating condition. The exploded vessel had been regularly inspected by the most approved inspection methods and gave no indication whatever that it was other than sound. Yet it exploded. The New York & Pennsylvania Company was fortunate in that it had insurance under a Hartford Steam Boiler policy.

Notes on the Care and Operation of Electrical Apparatus.

Prepared by the ELECTRICAL DEPARTMENT

CLEANLINESS.

FOR reliable operation, electrical apparatus must be thoroughly cleaned at regular and frequent intervals. If not given this attention, the ventilating ducts soon become choked with dirt, which prevents the circulation of a proper supply of cooling air and causes the windings to become overheated.

Dirt deposits usually contain particles which will conduct electricity, and these particles greatly increase the probability of a grounded coil. In fact, complete failure of a winding has frequently been traced to an accumulation of dirt.

Deposits of dirt (when dry) may best be removed by blowing out with compressed air at a pressure not exceeding 40 lbs. If the supply of compressed air is at a greater pressure than 40 lbs., a suitable pressure reducing valve should be installed in the line, since the use of air at a higher pressure will result in serious damage to the insulation. If compressed air is not available, a hand-bellows may be used to fair advantage.

Oil or grease should never be permitted to accumulate on the windings since such deposits shorten the life of insulation, and in addition these deposits collect dirt, forming a gummy, heat insulating covering which prevents the proper radiation of heat. The best way to remove oil or grease from the windings is to wash them with carbon tetrachloride or high proof gasoline. Gasoline is less expensive but it is very explosive and must be used with care.

Exposure to moisture from the surrounding air or from direct dripping of liquids is responsible for many grounded windings. Therefore, ventilated metal shields, or other methods of protection, are necessary in all cases where electrical equipment is installed in damp or otherwise unfavorable locations.

The life of a winding will, in many cases, be greatly lengthened by the application of a coat of high grade insulating varnish. This is especially true of an old winding or one that has been subjected to moisture, oil or dirt. Before applying the varnish the windings should be thoroughly cleaned and dried. Varnish can best be applied by means of a spray pot and compressed air, rather than with a brush.

LUBRICATION.

Proper lubrication of rotating equipment is of the utmost importance and should be given careful attention. Only high grade mineral oil of such density as to be readily carried by the oil rings should be used. The oil in each bearing reservoir should be kept at a level slightly below the top of the overflow cups and all flooding should be avoided, since the excess oil is usually drawn into the windings. Additional oil required to maintain this level is usually referred to as " make-up oil " — it should be supplied through the overflow cups, and preferably while the machine is at rest. If make-up oil is poured into the bearings while the machine is in operation, a certain amount is carried on the rings and shaft and in the grooves; and, when the machine comes to rest, drains into the wells and causes overflowing.

Oil wells should be drained and washed out with kerosene at regular intervals and supplied with new oil, the intervals depending upon local conditions. For example, bearing oil for a rock crusher motor should be changed more often than bearing oil for a motor located in an engine room.

Bearings should be observed daily, if practicable, or at least every time the machine is placed in operation to see that the oil rings are turning and carrying oil.

COMMUTATORS.

A commutator in good condition has a highly polished chocolate colored surface and nothing should be done which will tend to destroy this finish. However, if the commutator is blackened, or the brushes are cutting, or sparking is present, immediate attention should be given. A loose " V " ring, high or low bars, high or oil soaked mica will cause blackening of the commutator and severe arcing, resulting in rapid burning at the brushes and eventually in serious trouble. To remedy such troubles, the " V " ring should be tightened, and the commutator should be turned and polished with fine sand-paper. If the commutator is badly oil soaked, it should be re-insulated with new mica.

Often the mica between bars is very hard and wears more slowly than the copper, or it is not completely cured when placed in the commutator, resulting in high mica. In such cases, the mica should be slightly undercut (say about 3/64″), and the edges of the bars should then be slightly beveled to prevent the slots from becoming filled with carbon or copper dust. Only experienced workmen should attempt to true and polish or undercut commutators.

Some of the more frequent causes of sparking are: (1) heavy overload; (2) oily or dirty contact surfaces; (3) brushes improperly fitted or of incorrect grade; (4) brushes badly worn or sticking in holders; (5) excessive vibration or insufficient brush spring pressure;

(6) bars short circuited or trouble in armature coils; (7) brush studs incorrectly spaced or not on electrical neutral; (8) improperly laced belt joint.

Brushes, Brush Rigging and Collector Rings.

The brushes are the connecting link between the supply lines and the machine. Therefore it is necessary that they be properly ground to insure complete bearing surface at the point of contact with the commutator. When renewing worn or broken brushes, do not depend upon the brushes "wearing themselves in," as this practice will cause the commutator to heat and become rough because of poor brush contact. A satisfactory brush fit is best secured by sandpapering the brushes while in their holders, using the commutator or collector rings as a guide to secure the proper curvature. Care should be taken to hold the sandpaper down against the commutator, to avoid rounding the heels and toes of the brushes.

Lubrication of brushes is undesirable and if the brushes are of the proper grade it is unnecessary. However, in cases where some lubrication is absolutely necessary it is best to slightly moisten a piece of heavy canvas with vaseline or a good grade of mineral oil and apply to the commutator. Even in such cases the lubricant should be applied sparingly. Brush shunts should always be firmly attached to the brush holders to prevent heating, and replacement brushes should be duplicates of those supplied by the manufacturer of the machine. Excessive brush pressure causes heating of contact surfaces and should be avoided.

In order to provide even wear across the face of the commutator and to prevent "grooving," the brushes should be staggered by "pairs of brush arms." That is to say, the brushes on one positive arm and those on an adjacent negative arm, should be placed near the outside end of the commutator (but they should not overhang) while the brushes on the next two arms should be located near the commutator risers and so on around the commutator.

The Brush Rigging should be kept clean and free from oil and dirt. Failure to take proper care of the brush rigging often causes "flash overs," or arcing from one brush arm to the next, resulting in the burning out of the armature. In many cases, dirt, oil or carbon dust causes the brush arm insulation to become grounded or to show low insulation resistance.

Low insulation resistance of A.C. generator fields, armatures of rotary converters or rotors of wound rotor motors can often be traced to an accumulation of conducting substance on the collector ring insulation, or on the leads between the winding and the rings. It is, therefore, very important to keep the collector ring assembly, the leads, etc., free from any foreign matter.

Overload Protection.

Protection of electrical machines against overload is absolutely necessary and the care and maintenance of the protective devices, assuming that suitable ones have been provided, is likewise essential, in order to assure proper functioning of the protective equipment. The weak spot of an electrical machine is, of course, the insulation, and the life of the winding is vitally affected by the temperature to which the insulation is subjected. Overload causes more current to flow than the winding is designed to carry, resulting in excessive temperature which leads to rapid deterioration of the insulation.

Small motors are usually started by throwing them directly across the line, and this practice necessitates the use of fuses of large enough capacity to take care of the starting current, which is from three to five times normal full load current. Obviously, fuses of such capacity permit the roasting out of the winding if sufficient overload is applied. Double throw switches with starting and running fuses are often used, but in many cases, switches of this type actually increase the danger to the motor. The operator may not hold the switch in the starting position long enough to bring the motor up to speed, or he may be slow in throwing the switch to the running position, thereby blowing one fuse. The motor then operates single phase and the winding is burned out.

Probably the best and least expensive method of properly protecting such motors is by the use of "thermal relays or cut-outs," or "time delay fuses." These devices permit a relatively large flow of current for a limited time, such as the starting period, but they will open the circuit in case the overload continues. Fuses of this type as manufactured by the Westinghouse Company, the General Electric Company, or other manufacturers, are recommended.

In general, protective devices for motors should be set approximately 25% above the full load current rating as stamped on the nameplates, although there will be many cases where operating conditions require a higher setting. Setting the circuit breaker of a direct current generator at 150% of the nameplate rating will usually give satisfactory results, if the various feeder circuits are properly protected. It is good engineering practice to connect alternating current generators to the bus bars without any overload protection whatever. The feeder circuits, however, must be properly protected.

If a 2 or 3 phase motor is protected by fuses or "thermal cut-outs" all of the fuses or cut-outs for a given machine or circuit should be of the same capacity; and if relays are used, all of the relays should be set at the same value.

General Instructions.

Fuse clips, knife switches, oil circuit breaker fingers, carbon circuit breaker contacts and all other movable current carrying parts should be inspected at regular intervals for loose, corroded, or burned surfaces in order that such conditions may be remedied before service is interrupted.

The metal frames of practically all electrical equipment should be permanently grounded for by so doing, the life hazard is reduced.

Power failure on one wire of a 2 or 3 phase circuit due to a blown fuse, or other cause, will frequently result in continued operation of connected motors on single phase power. If a motor operating under such conditions is carrying as much as one-half its rated load, excessive heating of the winding will take place, and if the trouble is not discovered promptly the winding is certain to roast out. A starter for an A.C. motor may make perfect contact for all phases in the starting position but cause a single phase burn-out when thrown to the running position because of defective contacts or a blown fuse. All fuses of any group of fuses for a two or three phase motor must be of the same capacity.

Tools, or other metal objects should not be placed upon the frame or within the magnetic field of rotating machines. Likewise,. switch cabinets, cut-out boxes or other live part enclosures should not be utilized as "handy places" to keep tools, waste, etc.

A name plate supplies valuable information. It should not be removed from the machine to which it was originally attached. Changes of characteristics due to re-connecting or rewinding should always be properly indicated by re-stamping the name plate or by supplying a new plate properly stamped.

The field winding of a rotary converter or a synchronous motor is subjected to a high induced voltage while being started from the A.C. side. Therefore, the instructions supplied by the manufacturer directing the use of a field break-up switch, field discharge resistance, etc., should be faithfully carried out.

Avoid short pulley centers as well as a vertical drive for a belted load. Either condition requires excessive belt tension, and results in rapid wear of the bearings.

Temperature.

The temperature at which an electrical machine operates is of vital importance. Therefore attention should always be given to the question of ventilation, especially when the object is located in a closed room, or near a steam line, or where the temperature of the surrounding air is unduly high. It is impossible to determine the temperature of an electrical machine by placing the hand on the frame or coils. In order to secure accurate information a high grade thermometer should be used. The maximum safe operating temperature is usually given in degrees Centigrade. If only a Fahrenheit thermometer is available the reading may be converted by the following table:

Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.
0	32	30	86	60	140	90	194
5	41	35	95	65	149	95	203
10	50	40	104	70	158	100	212
15	59	45	113	75	167	105	221
20	68	50	122	80	176	110	230
25	77	55	131	85	185	115	239

The dielectric strength of transformer oil decreases rapidly with the absorption of moisture. One part water in 10,000 parts oil has been known to decrease the dielectric strength 50%. Oil samples from each tank except, of course, small distribution transformers, should be given a break-down test at least once each year for low voltage apparatus and once each month for high voltage equipment, so that moisture may be promptly detected and removed by filtering. Transformer oil should also be examined regularly for sludging. Likewise the condition of circuit breaker oil should be periodically determined.

When a machine is known to be defective or inoperative for any reason the starting device should be suitably placarded, and completely blocked if possible.

All overspeed devices should be carefully tested at regular intervals to be sure they function properly and to permit the correction of any irregularities before an emergency arises.

Approximate Full Load Current For Induction Motors.
Amperes Per Terminal.

H. P.	Amps. 1 Ph.	Amps. 2 Ph.	Amps. 3 Ph.	H. P.	Amps. 1 Ph.	Amps. 2 Ph.	Amps. 3 Ph.
0.5	3.4	1.7	1.8	30	140	70	81
1	6	3	3.2	40	190	95	109
2	10	5	6	50	220	110	127
3	15	7.5	9	75		165	192
5	26	13	15	100		215	248
7.5	40	20	22	150		320	366
10	50	25	29	200		410	475
15	70	35	41	250		510	590
20	96	48	55	300		600	700

Above Values are for 220 Volts.

For 110 Volts double above values. For 550 Volts use 2/5 above values.
For 440 Volts use ½ above values. For 2200 Volts use 1/10 above values.

Explosion of a Rotary Boiler.

ON September 25th, 1924, a rotary boiler exploded in the plant of the Lincoln Paper Mills, Ltd., Merritton, Ontario, with a resulting property loss estimated at $12,000, part of which is shown in Fig. 1. The failure was in one head, the head being blown about 30 ft. in one direction while the main part of the boiler went about 300 ft. in the opposite direction. It struck the ground once, tumbled endwise and came to rest on the far side of a pond, as shown in Fig. 2.

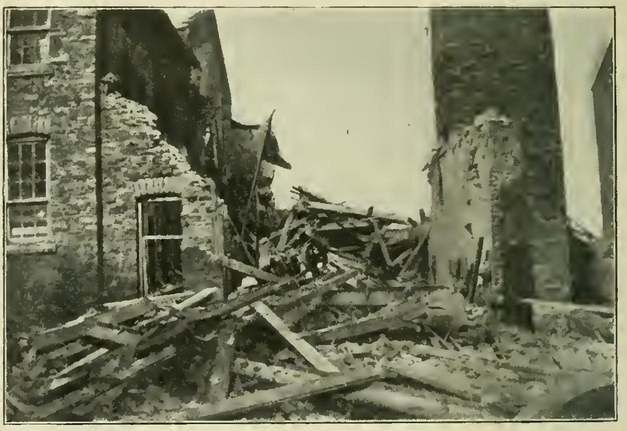


Fig. 1.

Rotary boilers are largely used in paper mills for light cooking operations in the preparation of paper stock, such as the boiling of rags, old papers, old ropes, etc., in which the chemical structure of the material is not required to be broken down or else does not require very drastic treatment. They are usually cylindrical in shape and of considerable length, and are suspended in a horizontal position from trunnions attached to the heads so that, as the name implies, rotary motion may be imparted to them. The vessel is charged with stock and chemicals through manholes, water and steam being later admitted through the hollow trunnions. It is therefore an unfired pressure vessel.

The rotary that exploded at the above location was apparently about 30 years old, judged by its appearance and condition, and was operated at 40 lbs. pressure. It was 79 inches in diameter by 25 ft. long, and was made of 5/16 inch plate in eight courses, three sheets to a course. The heads were of 7/16 inch plate curved to a 79 inch radius and concave to pressure, or plus heads. Details of construction indicate that, with a suitable factor of safety, the allowable pressure for the shell when new would be just about the pressure at which it was operated, 40 lbs. The heads, considered from the stand point of pressure only, were good for considerably more than this, but it must be remembered that they were subjected to a combination of stresses as a result of the way in which the boiler was suspended.

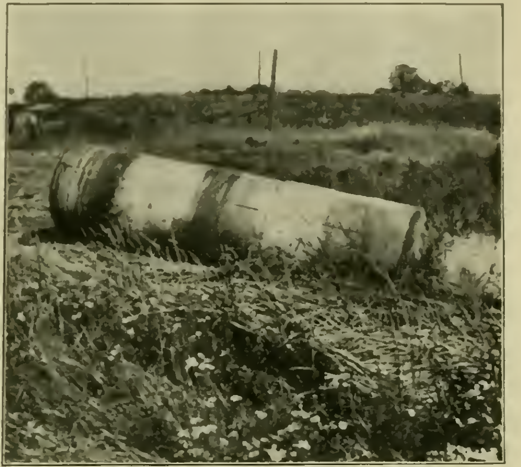


Fig. 2.

The initial failure was in one of the heads and an examination of the torn plate reveals the cause of the explosion. The rupture clearly shows that a crack ran for a considerable distance along the bend of the flange, and the indications are that this crack had existed for some time. Serious external corrosion had taken place and perceptibly thinned both the shell and the heads. Thus weakened, the head plates probably underwent a slight expansion and contraction, or " breathing," as the vessel was alternately under pressure and released from pressure. The result would be a continual bending action at the turn of the flange, and finally a cracked head.

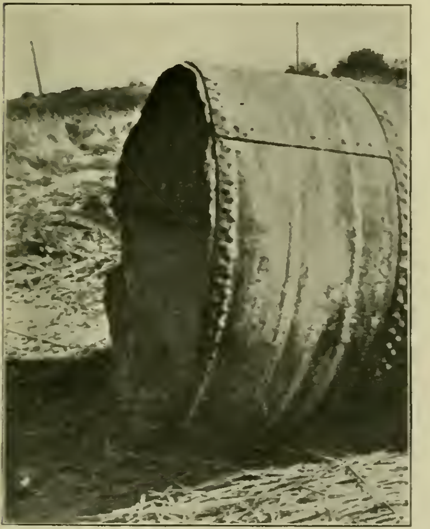


Fig. 3.

The shell of the boiler came out of the accident almost unscathed, but the opposite head suffered some damage, a large piece having been knocked out, most likely by collision with some other object.

Although this explosion appears to have been due solely to the deteriorated condition of the boiler, yet it is interesting to note that the safety valve, which was supposed to protect the vessel against over pressure, when recovered was said to have been in an inoperative condition.

Only one man was injured in the accident and he but slightly, as the explosion occurred at night and the only attendant was in another room protected by a stone wall. The property damage, however, came near being very much greater than it was. The boiler, as it traveled through the air, very likely described a rather flat trajectory due to its horizontal position in the mill. A substation, which was directly in its path, must therefore have escaped damage by a very close margin. Had the substation been wrecked, the operation of the mill would have been seriously interrupted.

This rotary is said to have been insured.

The Transverter.

A NOVEL piece of electrical apparatus which its sponsors expect will exert considerable influence in the future development of long distance transmission of electrical power was exhibited for the first time at the recent British Empire Exhibition at Wembley. The "transverter," the invention of W. E. Highfield and J. E. Calverley, is being brought out by the English Electric Co., Ltd., and is reported to have been the most interesting piece of electrical equipment exhibited. An excellent description of this invention recently appeared in *Engineering* (London), to which we are indebted for much of the material in this article.

The object of the transverter is to change over alternating current at generating voltages to direct current at higher voltages for transmission purposes. It has been found most satisfactory, primarily because of insulation difficulties, to generate electric power at moderate voltages. On the other hand, it is well known that such power can best be transmitted at extremely high voltages, high tension lines carrying 220,000 volts being in use today in some systems. These two opposing conditions can readily be harmonized in the case of alternating current. Transformers having the proper characteristics are placed between the generating and transmission systems and at suitable distributing points along the transmission lines and serve to step up or step down the voltage. Transmitting alternating current at high voltages, however, is attended by troubles due to the inductance and capacity of the line, particularly when the distances are great. Serious trouble of this nature was encountered when the first submarine cable was laid. As the cause was not then understood it is said to have created considerable trouble and even resulted in the operators accusing each other of being befuddled when sending signals. Such troubles are not present in direct current circuits so the advantage of using continuous current for transmission purposes is obvious. The difficulty has been in obtaining the high voltages. On a direct current circuit, a high voltage cannot be generated directly nor can it be stepped up with a transformer. Hence the relative unimportance of direct current today in the distribution of electrical energy.

The transverter is a machine designed to receive alternating current at a generating voltage and convert it into direct current of a higher voltage. Being entirely reversible, it is planned to place a second machine at the receiving end to make the reverse change. The advantages of alternating current with respect to generation and local distribution are clearly recognized and it is not expected to substitute for the present methods but rather to supplement them.

To change from high tension alternating current to low voltage direct current ordinarily requires a step down transformer and a rotary converter. The transverter, in performing a similar function, that is, changing moderate voltage alternating current to high tension direct current and vice versa, really takes the place of these two pieces of apparatus, hence its name.

Without going into too much detail, an idea of the principle upon which the machine operates may be obtained by comparing it with an ordinary direct current generator. In the latter the field windings are excited and the armature revolved in the magnetic field thus produced. An alternating current is produced which is changed by the commutator and brushes so that it becomes continuous current in the external circuit. The same result might be obtained by holding the armature stationary and revolving the field, a procedure followed in alternating current generators. Going a step further, the transverter utilizes the principle of a rotating magnetic field in stationary windings, the armature and field coils as well as the commutator remaining stationary while the brushes revolve at proper, or synchronous, speed around the commutator. The difficulties of commutation at the higher potentials are overcome by having several sets of windings on the same core. All sets are exposed simultaneously to the same magnetic field so that by having a commutator for each set of windings and connecting the commutators in series, the potential across each set of commutator bars is limited while the potential of the external circuit is the sum of the individual voltages. In other words, several direct current generating units are placed on the same mountings and connected in series.

The transverter which was shown at the Exhibition is of 2,000 kw. capacity. It is designed to receive three-phase, fifty cycle alternating current at 6,600 volts and convert it into continuous current at 100,000 volts. Eight commutators and an equal number of windings are required.

The transverter is undoubtedly a development of great interest coming as it does into a field in which methods are apparently closely approaching the maximum efficiency attainable. Its effect upon the electrical industry cannot be foretold at present as but two of these machines have been built and these are of a size too small to be considered for commercial operation. If larger units can be developed, it is predicted by some engineers to occupy a prominent place in future long distance transmission of electrical energy.

Mud-Daubers Hoodwink Inspector.

By Inspector J. T. Leary, Pittsburgh Department.

WHILE on a visit of inspection a few years ago at a mine, the Master Mechanic remarked that since the writer's previous visit the boilers had been inspected by another inspector (not connected with the Hartford Company) and repairs had been made as recommended. Questioned as to the nature of the repairs, he explained that they consisted of renewing a number of staybolts in the throat sheet of the locomotive boiler. The repairs, he added, were made under protest as they did not consider the staybolts defective.

" You see it was this way," the Master Mechanic explained, " the boiler hadn't been fired up since early in the spring. The outside of the boiler was covered with lagging, but some mud-dauber wasps had gotten in and filled up the telltale holes in the throat sheet with mud. The other inspector thought this an indication of fractured staybolts, and so ordered them renewed."

This wasp story did not make a very strong appeal to the writer at the time although he was quite familiar with the habits of the mud wasp. Some time later, however, a visit of inspection was made to another plant, and the story took on a different aspect. A new locomotive type boiler had previously been installed, operated for a few months, and then stored in a shed. It was noted on this visit that the telltale holes of the boiler were closed with mud. Had it not been for the story of the mud-dauber wasps in the first instance, and had the Inspector not known the age of the boiler and length of time in service, he, too, would undoubtedly have thought he had discovered several hundred fractured staybolts.

When inspecting boilers, it is not uncommon for the inspector to find various " objects foreign to steam boilers," particularly when the boilers have been idle for some time. On one occasion, for instance, the examination of a locomotive type boiler revealed a bee's nest in each of two tubes. The honeycombs extended about six inches into the tubes, but fortunately (for the inspector) had been deserted. On another occasion a live snake was found coiled comfortably around the safety valve. The report adds, "This defect was forcibly removed."

Other remarkable discoveries are recounted in the following clippings. The first one is offered as a suggestion of the " thrill " that may some day be experienced by an unwary inspector. Regarding the second clipping, our correspondent makes the comment, " This is evidence that they still use wood when lighting fires in locomotives."

FIRE ROUTS OWL FROM DOWNY BED IN BOILER BOX

Sisterville, W. Va., Dec. 29.— Owls have a reputation for being intelligent, but there's a limit to it — they can't see into the future. At least one, a resident of this section, will agree that he, or she, as the case might be, had a hot time of it when John B. Keller, an oil field worker, built a fire in a boiler on location.

Up jumped Old Man (or Lady) Owl, furnishing a scream worthy of an eagle, when Keller set a match to oil-soaked material in the firebox, which the wise bird had chosen for a temporary home. Keller admits he was thrilled. The owl was rescued.— *Pittsburgh Sun.*

SLEEPING MAN TRAPPED IN FIREBOX AS ENGINE IS FIRED UP

Syracuse, N. Y., March 15.— (A. P.) — Horace Harris, a locomotive boiler inspector for the New York Central Railroad, lay down for a nap early today in the firebox of a locomotive he had just inspected.

An hour later the locomotive was ordered out and a firemen kindled a fire in the box, not noticing Harris. The inspector awoke to find himself trapped with a wall of flame between him and the door, nearly six feet away.

The fireman, however, had left the door open and Harris plunged through the flames, falling unconscious on the floor of the cab. He was in a hospital tonight in a serious condition.— *Pittsburgh Gazette Times.*

Causes and Prevention of Boiler-Tube Failures.

PROBABLY the most frequent cause of boiler-tube failure is low water due to carelessness, to lack of adequate boiler-feed equipment or to failure to keep equipment in good operating condition. However, there is another cause which has not been so generally recognized, and that is the use of gate valves on boiler-feed lines. At one plant with which the writer was formerly connected seven tube failures occurred in one year, of which five were due to this cause. Even though a gate valve is provided with a rising stem it is impossible to tell the location of the valves by the position of the handwheel. Gates have been known to come loose from stems and the valves to remain closed when the stem has been brought into the open position. Two of the five failures were caused by this condition. The water tender had observed high water in the boiler and had closed the control valve, forcing the gates tight against the seat. When he again attempted to open the valves the gates pulled loose from the stem, leaving the valve entirely closed while the stem came into the open position.

Venturi Meter With Every Boiler.

It has become the regular practice of the Consumers Power Company to install a Venturi meter with every boiler. When used with centrifugal pumps and pure water, they give very accurate results, and in case of low water they indicate whether or not the water is being supplied to the boilers. Had Venturi meters been installed in the boiler feed in a plant where five boiler explosions occurred, the explosions would have been prevented. The expense thrown on the company by any two of the explosions would have justified the cost of the installation of the meters on all boilers.

Scale is another common cause of boiler-tube failures. This can be prevented by frequent use of air or water-power cleaners. The air cleaners are more economical where the plant is supplied with an air compressor of sufficient capacity, as they will operate more rapidly than a water-operated cleaner. This method of cleaning is very effective where a regular schedule is maintained to prevent undue accumulation of boiler scale. It necessitates, however, that the boilers be out of operation for a number of hours at frequent intervals. The work is often hot and tedious.

In virtually every case the proper use of soda ash or sodium silicate or lime and caustic soda or barium hydrate will produce better results than can be obtained with boiler compounds at anywhere from one-tenth to one-half the cost. In no case, however, should the treatment be carried on without competent, reliable tests being made for boiler alkalinity, free lime and amount of solids in solution. Some accurate check should also be made of boiler priming. Priming may be quite pronounced without material fluctuation of the water level in the gauge glass.

Boiler Water Treatment.

A very simple method of boiler-water treatment where the amount of sodium is low is by the use of a zeolite softener. This method has the disadvantage, however, that incrusting materials are changed into a soluble form and carried into the boiler instead of being thrown down in the treating equipment. Hence the boiler blowdown must be greater than with other methods of external feed-water treatment.

Evaporators provide a means of producing pure water for makeup purposes in limited quantities at a very reasonable cost and when properly installed and operated will keep the boilers almost entirely cleaned. There is no danger of priming or foaming and the blowdown can be almost entirely eliminated.

The presence of oil in boiler-feed water has frequently caused serious tube troubles. This is usually indicated by small blisters on the boiler tube, which are generally smaller in diameter than those due to scale trouble. The only real proof of oil or lack of it is to send a small sample of the scale to a chemical laboratory, where ether can be passed through it until all the oil has been dissolved, after which the ether is evaporated, leaving the oil. — *J. W. MacKenzie, "Electrical World," Nov. 29, 1924.*

Correspondence Course for Firemen.

THE Hartford Correspondence Course for Firemen is a complete course of study covering the subjects of combustion and the care and operation of boilers. It consists of twenty-four lessons, accompanying each of which is a set of questions on the subject matter of that lesson. The student answers the questions in writing and submits his answers to the Correspondence Course Department. Each lesson paper is graded and returned to the student together with comments and helpful suggestions regarding the work. After completing the lessons, a final examination is given reviewing the whole Course. If satisfactory grades have been obtained, a certificate to that effect is issued to the student. Much interest is manifested by the firemen and engineers enrolled who frequently, upon com-

(Continued on Page 181.)

The Locomotive

DEVOTED TO POWER PLANT PROTECTION
PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, APRIL, 1925.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

IN this day of automatic machinery, close tolerances, scientific lubrication, and metallic alloys, as well as of high costs of producing all these, much is expected of machines — and much is received. Long life, smoothness of operation, minimum attention and maintenance are characteristics featured by the manufacturers, and the purchasers of machinery from reliable manufacturers are not likely to be disappointed. Electrical machinery in particular, from its very nature, must be purchased largely by dependence upon the reputation of the maker. The inaccessibility of the various parts makes defects less obvious, while ability to stand up in use is not always a matter for test. Partly for this reason and others, great strides have been made in the design of such machines, and their compactness, durability and ruggedness is remarkable. Yet in common with all other types, a certain minimum amount of attention is required. Cleaning, lubrication, testing, adjustment, must all receive due and timely consideration to insure satisfactory operation and long life. To assist those wishing to take the necessary stitch in time the " Notes on the Care and Operation of Electrical Apparatus " presented elsewhere in this issue have been prepared by our Electrical Department. This material has also been issued printed on a manila card folder convenient for framing or hanging near the electrical equipment. Copies of this folder sufficient for your needs may be had gratis upon application to the Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.

Obituary.

William H. Spedding, former special agent in our New York Branch, died at the home of his brother in Lowell, Mass., on October 22, 1924.

Mr. Spedding was born October 7, 1856, at Stafford Springs, Conn., and entered the service of the Hartford Company in May 1903 as a special agent in our St. Louis office. In September 1905 he was transferred to the New York Branch, and later was appointed resident agent for the Company for New Jersey and became a resident of Jersey City.

Correspondence Course for Firemen.

(Continued from page 179.)

pleting the Course, write to let us know how valuable it has been to them. The following interesting letters are typical.

A Fireman's Opinion.

Dear Sir: —

I herewith beg to acknowledge receipt today of yours of the 28th with enclosed certificate. I am more than pleased with the course and knowledge acquired through same. It made me think; and that is more than I would have done reading an ordinary book on this subject, and at the same time it impressed upon my mind the facts by forwarding the written answers. Thanking you for your assistance and looking forward to a time when possibly an advanced course along this or similar boiler work may be offered to the men with the shovel.

Yours truly,

A Plant Engineer's Opinion

Dear Sir:

I received my certificate for the Combustion Course and must ask your pardon for this late acknowledgment.

In looking over the papers, I can see where I might have been more explicit in some of my answers and obtained higher rating, but the principal object is that I have the information for which I was seeking. I should like to tell you my reasons for taking the course.

The steam proposition at the ——— ——— Company is quite modest being two H.R.T. boilers run at low pressure for heating only. During the run of a week day and night shift I have four firemen of varying degrees of experience. While I have had a broad experience in plant upkeep in general, I have not personally fired a boiler for any length of time, consequently, I did not feel at liberty to criticise the work of the various men which varied quite a little in methods and results.

As a result of the course I have been enabled to offer suggestions as to ways of handling the firing proposition which have been well received and by which we have all profited.

I was much interested when going over the papers with the oldest fireman to have him frequently say, " Well now I have often done that but never knew why till now." My best man came from a Vermont farm and has been the most interested pupil of the lot. A remark from the purchasing department was very gratifying to me. " It seems that the coal is holding out better this winter than usual." Thus far we have not had an exceptional hard winter, which may account for part of the good record, but I am very sure the Course should have some credit. As the outlook is now, we shall lower the record of coal burned at least 10% and possible 12½% under all previous records.

I wish to thank you most heartily for your patience and consideration during the course and assure you that I appreciate the efforts of the School and results obtained.

Respectfully yours,

The Metric System.

The Metric System of Weights and Measures is a valuable handbook published and placed on sale by The Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn. This publication contains the metric equivalents of all English or United States units of measurement, as well as Conversion Tables for measures of length, area, volume, weight, liquid capacity, work, heat and temperature. A brief but interesting history of the Metric System is also included. Substantially bound, pocket size, (3½″ by 5¾″) and indexed, price $1.50.

Summary of Inspectors' Work for 1924.

Number of visits of inspection made	241,599
Total number of boilers examined	471,374
Number inspected internally	177,218
Number tested by hydrostatic pressure	11,529
Number of boilers found to be uninsurable	1,172
Number of shop boilers inspected	12,101
Number of fly-wheels inspected	50,989
Number of premises where pipe lines were inspected	18,891

SUMMARY OF DEFECTS DISCOVERED.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	35,451	2,129
Cases of adhering scale	45,580	2,008
Cases of grooving	2,344	238
Cases of internal corrosion	26,162	1,090
Cases of external corrosion	13,449	1,189
Cases of defective bracing	953	302
Cases of defective staybolting	4,481	1,113
Settings defective	9,800	1,089
Fractured plates and heads	3,934	571
Burned plates	3,569	579
Laminated plates	300	46
Cases of defective riveting	1,626	385
Cases of leakage around tubes	13,191	2,518
Cases of defective tubes or flues	20,766	6,889
Cases of leakage at seams	6,237	542
Water guages defective	5,047	985
Blow-offs defective	4,901	1,382
Cases of low water	505	188
Safety-valves overloaded	1,324	328
Safety-valves defective	2,376	479
Pressure guages defective	7,978	857
Boilers without pressure guages	863	84
Miscellaneous defects	9,365	1,053
Totals	220,202	26,044

GRAND TOTAL OF THE INSPECTORS' WORK ON BOILERS FROM THE TIME THE COMPANY BEGAN BUSINESS TO JANUARY 1, 1925.

Visits of inspection made	5,879,173
Whole number of inspections (both internal and external)	11,611,306
Complete internal inspections	4,520,952
Boilers tested by hydrostatic pressure	421,383
Total number of boilers condemned	33,084
Total number of defects discovered	6,386,856
Total number of dangerous defects discovered	709,806

FLYWHEEL EXPLOSIONS DURING 1924.

No.	MONTH.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	Jan.	23	Pulley ruptured			Griswold Worsted Co.	Worsted Mill	Darby, Pa.
2	Feb.	5	Steam turbine exploded		1	St. Cloud Public Service Co.	Power Plant	St. Cloud, Minn.
3		11	Flywheel exploded			Interstate Iron & Steel Co.	Steel Plant	Chicago, Ill.
4			Flywheel exploded			Edw. Hines Yellow Pine Co.	Saw Mill	Lumberton, Miss.
5		15	Turbo-generator exploded			Penick & Ford, Ltd.	Corn Products	Cedar Rapids, Ia.
6		29	Flywheel exploded		2	U. S. Gypsum Mines Co.		Batavia, N. Y.
7	Mar.	8	Flywheel exploded	1		Frank Ward Farm	Portable Saw Mill	Sodus, N. Y.
8		12	Pulley exploded			Chesapeake Corporation	Pulp Mill	West Pont, Va.
9		13	Flywheel exploded	1	1	Little Falls Paper Co.	Paper Mill	Newburg, N. Y.
10	Apr.	10	Flywheel exploded		5	Coos Bay Lumber Co.	Lumber Mill	Marshfield, Ore.
11			Flywheel exploded			So. Michigan Power Co.	Power Plant	Hudson, Mich.
12		14	Flywheel exploded	1	1	DeNeal Samuels, Inc.		Brooklyn, N. Y.
13		30	Flywheel exploded		1	D. W. Alderman & Sons	Sawmill	Sumter, S. C.
14			Pulley exploded	1		Manning Paper Co.	Paper Mill	Green Is., N. Y.
15	May	8	Flywheel exploded		1	Packer No. 4 Mine	Mine	Shenandoah, Pa.
16		16	Flywheel exploded			Winton Lumber Co.	Lumber Mill	Gibbs, Idaho
17		21	Centrifugal drier exploded			Henderson Land Co.	Sugar Refinery	New Orleans, La.
18			Pulley exploded			Kehlor Flour Mills Co.	Flour Mill	St. Louis, Mo.
19	June	19	Flywheel exploded			White Frost Ice Co.	Ice Plant	Anderson, Ind.
20		20	Pulley exploded			Littlefield Ice & Coal Co.	Ice Plant	Hammonton, N. J.
21		24	Flywheel ruptured			Cracker Jack Company	Candy Factory	Chicago, Ill.
22	July	3	Flywheel of automobile exploded	1	1	Harry Hunter	Automobile	Seymour, Ind.
23		12	Centrifugal drier exploded		1	Long Island Carpet Cleaning Co.	Cleaners	Astoria, L.I., N.Y.
24		18	Flywheel exploded		1	Carolina Public Service Co.	Refrigerating Pt.	Greenville, S. C.
25	Aug.	7	Flywheel exploded		2	Jacob Hornung Brewing Co.	Refrigerating Pt.	Phila, Pa.
26		25	Pulley exploded			Winslow Bros. & Smith Co.	Tannery	Boston, Mass.
27	Sept.	17	Flywheel exploded	1			Cotton Gin	Bamberg, S. C.
28		20	Flywheel exploded		3	Kerens Cotton Oil Mill	Oil Mill	Kerens, Tex.
29		23	Flywheel exploded			Cambria Coal Mining Co.	Mine	Briceville, Tenn.
30	Oct.	4	Flywheel exploded	1	1	Grandfather Falls Co.	Paper Mill	Merrill, Wis.
31		25	Flywheel exploded	1		Price Jennings Farm	Portable Sawmill	Markle, Ind.
32		28	Flywheel exploded			Bernicia Tannery	Tannery	Bernicia, Cal.

33			Flywheel of Diesel engine exploded *			City of Vernon	Power Plant	Vernon, B. C.
34	Nov.	1	Flywheel of hydr. turb. exploded			St. Cloud Public Service Co.	Power Plant	St. Cloud, Minn.
35		6	Flywheel exploded	1		American Nickel Alloy Co.		Clearfield, Pa.
36		11	Flywheel exploded	1		George Allen	Portable Saw Mill	Danby, Vt.
37	Dec.	19	Flywheel exploded		1	T. A. Murphy	Grain Mill	Seaman, Ohio
38		20	Pulley exploded			Great Western Sugar Co.	Sugar Mill	Greeley, Colo.
39		30	Flywheel exploded		1	Park Mills	Paper Mill	Marinette, Wis.

*1923 accident.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF APRIL, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
282	15	Five headers cracked			Est. J. W. Arrott	Office Bldg.	Pittsburgh, Pa.
283		Tube ruptured			Lima Locomotive Wks.	Locomotive Wks.	Lima, Ohio.
284		Eighteen sections heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Plainfield, N. J.
285	17	Two sections heating boiler cracked			Fordham M. E. Church	Church & Apts.	New York, N. Y.
286		Boiler bulged and ruptured			Mowrystown Brick & Tile Co.	Brick & Tile Plt.	Mowrystown, O.
287		Boiler exploded		1		Excavator	Gillette, Ark.
288		Ammonia tank exploded		2	Wm. H. Breen	Grocery Store	Kansas City, Mo.
289	18	Tube ruptured		1	Rhodes Steam Laundry	Laundry	Stuttgart, Ark.
290		Two sections heating boiler cracked			Walter Fruend Bread Co.	Bakery	St. Louis, Mo.
291		Two sections heating boiler cracked			Loew's Palace Theatre	Theatre	Brooklyn, N. Y.
292	19	Three sections heating boiler cracked			N. Y. Cotton Exchange	Office Bldg.	New York, N. Y.
293	21	Tube ruptured		1	American Screw Co.	Screw Factory	Providence, R. I.
294		Tube ruptured		2	Hammond Lumber Co.	Lumber Mill	Los Angeles, Cal.
295	23	Tube ruptured			American Steel & Wire Co.	Steel Wire Mill	Joliet, Ill.
296		Blow-off pipe failed			A. G. Pugh	Asphalt Plant	Columbus, Ohio.
297	24	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
298	25	Three sections heating boiler cracked			Meserole Exhibition Co.	Theatre	Far Rockaway, L. I., N. Y.

MONTH OF APRIL, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
299	25	Boiler exploded		1	Western Asphalt Co.	Paving Plant	Eagle Grove, Iowa.
300		Feed water heater exploded		1	Thomas Mfg. Co.		Springfield, O.
301	26	Boiler exploded	3	2	Standard Oil Co.	Oil Well	Santa Fe Springs, Cal.
302	28	Blow-off pipe failed			Massachusetts Laundry	Laundry	Detroit, Mich.
303		Header cracked			Monsanto Chemical Co.	Chemical Plt.	St. Louis, Mo.
304		Four sections heating boiler cracked			Standard Talking Mach. Co.	Sales Room	Pittsburgh, Pa.
305	29	Section of heating boiler cracked			Chas. S. Ashley & Sons	Office Bldg.	New Bedford, Mass
306	30	Section of heating boiler cracked			Thompson-McIntosh Realty Co.	Offices & Stores	Las Animas, Colo.
307		Crown sheet failed			California Construction Co.	Road Contractors	Fall Brook, Cal.

MONTH OF MAY, 1924.

308	1	Boiler bulged and ruptured			Belle Alkali Co.	Chemical Plt.	Belle, W. Va.
309	3	Boiler bulged and ruptured			Peterman Mfg. Co.	Woodworking Plt.	Tacoma, Wash.
310	4	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
311	5	Tube ruptured		1	Memphis Power & Light Co.	Power Plant	Memphis, Tenn.
312	7	Main steam line ruptured		1	C. C. Bell Mfg. Co.	Lumber Mill	West Monroe, La.
313		Boiler exploded		3	Texas Company	Oil Well	Norphlet, Ark.
314	8	Boiler exploded	1	1	L. F. Henderson	Saw Mill	Marshall, Ark.
315	9	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
316		Boiler of locomotive exploded	1	2	Wheeling & Lake Erie R. R. Co.	Railroad	Adena, Ohio.
317		Boiler of locomotive exploded		3	B. & O. R. R. Co.	Railroad	Holloway, Ohio.
318	10	Tube ruptured			Robinson Clay Products Co.	Clay Pipe Factory	Akron, Ohio.
319		Three sections heating boiler cracked			Valentine Theatre Corp.	Theatre	New York, N. Y.
320	11	Two sections heating boiler cracked			St. Marks Printing Corporation	Printing Plant	New York, N. Y.
321		Brine cooling tank exploded	1	6	Jessup & Antrim		Indianapolis, Ind.
322	12	Tube ruptured			Fairmount School	School	Breckenridge, Pa.
323	13	Boiler exploded	1		530 Woodland Ave.	Apts. & Stores	Cleveland, Ohio.
324		Boiler ruptured			Franco American Co.	Cleaners & Dyers	Indianapolis, Ind.
325		Main steam line failed	1	1	Lange & Crist Box and Lbr. Co.	Box Factory	Clarksburg, W. Va.
326		Section of heating boiler cracked			Buckner School Trustees	School	Buckner, Ill.

327	15	Section of heating boiler cracked			W. 61st Corp'n	Garage	New York, N. Y.
328		Boiler bulged and ruptured			Borough of Somerset	Water Works	Somerset, Pa.
329		Two sections heating boiler cracked			Liberty Co.	Office Bldg.	Boston, Mass.
330		Section heating boiler cracked			Lake Amusement Co.	Theatre	Minneapolis, Minn.
331		Two sections heating boiler cracked			Hale Bros., Inc.	Hotel	Sacremento, Cal.
332		Section of heating boiler cracked			Lake Amusement Co.	Theatre	St. Paul, Minn.
333		Manhole flange ruptured			Palmetto Ice Co.	Ice Plant	Columbia, S. C.
334		Boiler exploded			Graves Bros.	Lumber Mill	Hosford, Fla.
335		Boiler exploded			Southern Steam Laundry	Laundry	Heflin, Ala.
336	16	Section of heating boiler cracked			Friedman-White Realty Co.	Apt. House	New York, N. Y.
337		Boiler exploded	1		S. & J. Lininger	Saw Mill	Grafton, Pa.
338	17	Boiler exploded			Acme Process Co.	Sand Drying Plt.	Shreveport, La.
339	18	Five sections heating boiler cracked			Universal Service Motor Co.	Garage	Philadelphia, Pa.
340	19	Two sections heating boiler cracked			E. J. Gase	Bakery	Saginaw, Mich.
341		Tube ruptured		1	National Biscuit Co.	Bakery	New York, N. Y.
342	20	Section of heating boiler cracked			Ritz-Carlton Realty Co.	Hotel & Stores	Denver, Colo.
343		Four sections heating boiler cracked			Sowers Mfg. Co.	Foundry	Buffalo, N. Y.
344	21	Section of heating boiler cracked			Tumble Brook Country Club	Club House	Bloomfield, Ct.
345	22	Blow-off pipe failed			Auburn Last Co.		Framingham, Mass
346	23	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
347	24	Section of heating boiler cracked			Highland Hospital	Sanitorium	Asheville, N. C.
348	26	Fitting on main steam line failed			Penn Power & Light Co.	Power Plant	Williamsport, Pa.
349		Hand-hole plate blew out			Pfeifer Cleaning Co.	Cleaning Works	Little Rock, Ark.
350	28	Two sections heating boiler cracked			Aaron G. Cohen, Inc.	Commercial Bldg.	Hartford, Conn.
351	29	Boiler exploded		1	Frank Humbard	Saw Mill	Cleveland, Ohio.
352	30	Section of heating boiler cracked			Hyman Kaplan	Apt. House	Hartford, Conn.
353		Eight headers cracked			Colorado Laundry Co.	Laundry	Pueblo, Colo.
354		Boiler bulged and ruptured			Victoria Land & Canal Co.	Rice Farms	Thornwall, La.
355		Boiler exploded	1	1	Nicolas Erlinger, Jr.	Threshing Mach.	Bartelso, Ill.
356	31	Boiler exploded			M. & St. L. Rwy. Co.	Pumping Sta.	Grinnell, Iowa.
357		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.

MONTH OF JUNE, 1924

358	1	Two sections heating boiler cracked			Amer. Packing & Provision Co.	Store	Salt L. City, Utah
359		Section of heating boiler cracked			Maud Adams	Bank Bldg.	Kingsport, Tenn.
360		Section of heating boiler cracked			Herald Publishing Co.	Publishers	New Britain, Conn.
361		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.

MONTH OF JUNE, 1924 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
362	2	Three headers cracked			Keasby & Mattison Co.	Chemical Plant	Ambler, Pa.
363		Tube ruptured			Weirton Steel Co.	Steel Plant	Weirton, W. Va.
364		Boiler exploded	2		Diamond Drilling Co.	Oil Well	Gotebo, Okla.
365	3	Boiler of tractor exploded	1			Tractor	Dixon, N. D.
366	4	Boiler exploded	2	4	H. H. Starnes & Son	Sawmill	Mathiston, Miss.
367	5	Tube ruptured			Commissioners of Cook County	County Home	Oak Forest, Ill.
368		Boiler exploded	1		Frank Humbard	Sawmill	Cleveland, Tenn.
369		Section of heating boiler cracked			Esther E. Benson	Apt. House	San Francisco, Cal.
370	6	Crossbox and header cracked			American Soda Fountain Co.	Soda Fountain Pt.	Boston, Mass.
371	7	Tube ruptured			Amer. Water Wks. & Elec. Co.	Water Works	East St. Lo., Ill.
372	9	Crown sheet of locomotive failed	1	1	W. F., R. & Ft. W. R. R. Co.	Railroad	Ranger, Tex.
373	11	Boiler ruptured	1		Max Glick Mfg. Co.		Cleveland, O.
374	12	Tube ruptured			Pittsburgh Terminal Coal Co.	Coal Mine	Horning, Pa.
375		Circulating pipe ruptured			Standard Tire Co.	Tire Factory	Willoughby, O.
376	16	Four sections heating boiler cracked			Loew's, Inc.	Theatre	New York, N. Y.
377		Hot water heater exploded			Y. M. C. A.	Y. M. C. A. Bldg.	McPherson, Kan.
378		Tube ruptured			No. Ohio Traction & Lt. Co.	Power Plant	Akron, O.
379	17	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
380	18	Header cracked			Sheffield Farms, Inc.	Milk Station	New York, N. Y.
381		Boiler exploded	2	1	J. S. Pickle Lumber Co.	Lumber Mill	Jasper, Tex.
382		Hot water heater exploded		2	Grabowsky Bros.	Apt. Block	Holyoke, Mass.
383	20	Section of heating boiler cracked			Ramsay Realty Co.	Apt. House	New York City
384		Tube ruptured			American Sheet & Tin Plate Co.	Sheet Steel Plant	New Phila., Ohio
385	21	Boiler exploded		1	Farley N. Caldwell	Oil Well	Louisville, Ky.
386		Boiler exploded	1		Dredge "Missouri"	River Dredge	Kelso, Wash.
387		Boiler exploded	1		W. E. West Lease		Breckenridge, Tex.
388		Boiler bulged and ruptured			Crystal Ice & Fuel Co.	Ice Plant	Prescott, Ariz.
389	22	Section of hot water heater cracked			Bennett & Myers Investment Co.	Hotel & Stores	Denver, Colo.
390	24	Boiler of locomotive exploded	1	1	Wichita & Northwestern Rwy. Co.	Railroad	Byers, Kan.
391	25	Section of heating boiler cracked			Lippman & Lowy, Inc.	Office Bldg.	Newark, N. J.
392	26	Section of heating boiler cracked			Board of Education	School	Pittsburgh, Pa.
393	27	Tube ruptured			Standard Paper Co.	Paper Box Fcty.	Kalamazoo, Mich.
394	30	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
395		Hot water heater exploded			Y. M. C. A.	Y. M. C. A. Bldg.	Metuchen, N. J.

MONTH OF JULY, 1924

396	1	Section of heating boiler cracked			Masonic Bldg. Assn.	Masonic Temple,	Cleveland, O.
397	5	Section of heating boiler cracked			Sisters of Mercy, Inc.	Home for Aged	Oakland, Cal.
398	7	Section of hot water heater cracked			Edith M. Stidger	Apt. House	San Francisco, Cal.
399		Four sections heating boiler cracked			Wacht Rose Holding Corp.	Apt. House	New York, N. Y.
400		Boiler ruptured			Cartersville Ice & Coal Co.	Ice Plant	Cartersville, Ga.
401		Main steam pipe burst			Scovill Manufacturing Co.	Brass Factory	Waterbury, Conn.
402	8	Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
403		Five tubes pulled out of drum			American Sheet & Tin Plate Co.,	Sheet Steel Plant	Elwood, Ind.
404		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
405		Tube failed			Columbus Gas Co.	Gas Plant	Columbus, Nebr.
406		Two sections heating boiler cracked			Edgar Shoemaker	Apt. House	New York, N. Y.
407	10	Staybolts pulled out			Lexington Utilities Co.	Power Plant	Lexington, Ky.
408	11	Section of heating boiler cracked			Harry Rosenberg	Apts. & Stores	Detroit, Mich.
409	13	Boiler exploded		2	Rex Cannon	Oil Well	Wichita Falls, Tex.
410	14	Fifteen tubes pulled out of drum			The Texas Co.	Oil Refinery	Pt. Arthur, Tex.
411	16	Tube ruptured			Ft. Wayne Corrugated Paper Co.	Paper Mill	Hartford, Cy., Ind.
412	18	Boiler ruptured			Gulf States Steel Co.	Coal Mine	Birmingham, Ala.
413	21	Header cracked			Kingan Packing Assn.	Packing House	Richmond, Va.
414	22	Steam pipe ruptured	1		Elkins Box Co.	Box Factory	Elkin, N. C.
415	23	Section of hot water heater cracked			Sadie Marcellino	Apt. House	Hartford, Conn.
416		Ammonia tank exploded			John W. Wagner	Meat Shop	Phila., Pa.
417	24	Boiler exploded		2	Gen. Insulating & Mfg. Co.	Quarry	Alexandria, Ind.
418	25	Two sections heating boiler cracked			J. M. Barker	Office Bldg.	Bristol, Tenn.
419		Air tank exploded	1		Pittsburgh Rwys. Co.		Pittsburgh, Pa.
420	26	Boiler exploded		1	Armstrong Poultry Co.		Mendota, Ill.
421	28	Boiler exploded	4		W. G. Donovan Farm	Threshing Mch.	Cairo, Ohio
422	29	Boiler exploded			W. A. Parrott & Son		Center, Tex.
423		Boiler ruptured			Central Ice & Cold Storage Co.	Ice Plant	New Orleans, La.
424	31	Steam pipe exploded	2		Sinclair Co.	Refinery	Houston, Tex.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1924

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$312,885.77
Real Estate	255,000.00
Mortgage and collateral loans	1,797,000.00
Bonds and stocks	9,830,809.50
Premiums in course of collection	1,114,552.34
Interest Accrued	145,614.56
Total assets	$13,455,862.17

LIABILITIES

Reserve for unearned premiums		$5,897,736.62
Reserve for losses		258,782.17
Reserve for taxes and other contingencies		559,988.34
Capital stock	$2,500,000.00	
Surplus over all liabilities	4,239,355.04	
Surplus to Policyholders,		$6,739,355.04
Total liabilities		$13,455,862.17

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, Chairman Board of Trustees United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Vice-President The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President The Capewell Horse Nail Co. Hartford, Conn.
JOSEPH R. ENSIGN, President The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.
WM. R. C. CORSON, Vice-President The Hartford Steam Boiler Inspection & Insurance Co. Hartford, Conn.
SAMUEL M. STONE, President The Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, President The Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866 THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. James G. Reid, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn., 404-405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., 209 West Jackson B'l'v'd	P. M. Murray, Manager. J. P. Morrison, Chief Inspector. J. T. Coleman, Ass't Chief Inspector. C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio Leader Bldg.	A. Paul Graham, Manager. L. T. Gregg, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J. H. Chesnutt, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, General Agent. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y. 80 Maiden Lane	C. C. Gardiner, Manager. E. Mason Parry, Chief Inspector. R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9-10 Arrott Bldg.	Geo. S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	Bates, Lively & Pearson, Gen'l Agents. C. B. Paddock, Chief Inspector.
SEATTLE, Wash., 415 Dexter Horton Bldg.	C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
TORONTO, Canada, Federal Bldg.	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.

JUL 31 1925
OF PITTSBURGH, PENNA

PROTECT YOURSELF

against explosions of

Digesters
Economizers Laundry Mangles
Rendering Tanks Vulcanizers
Paper Machines

All pressure vessels should be insured against explosions such as the one illustrated on the front cover. The HARTFORD COMPANY *paid more than $99,000 on that explosion.*

Consult your agent or broker or fill out the blanks below and send for further information

---

THE HARTFORD STEAM BOILER
INSPECTION & INSURANCE CO.,
HARTFORD, CONN.

Please tell us what it would cost to include the following vessels in our policy:

No. of Vessels	Kind of Vessel	Length and Diameter

Name ....

Address ....

....

A 25

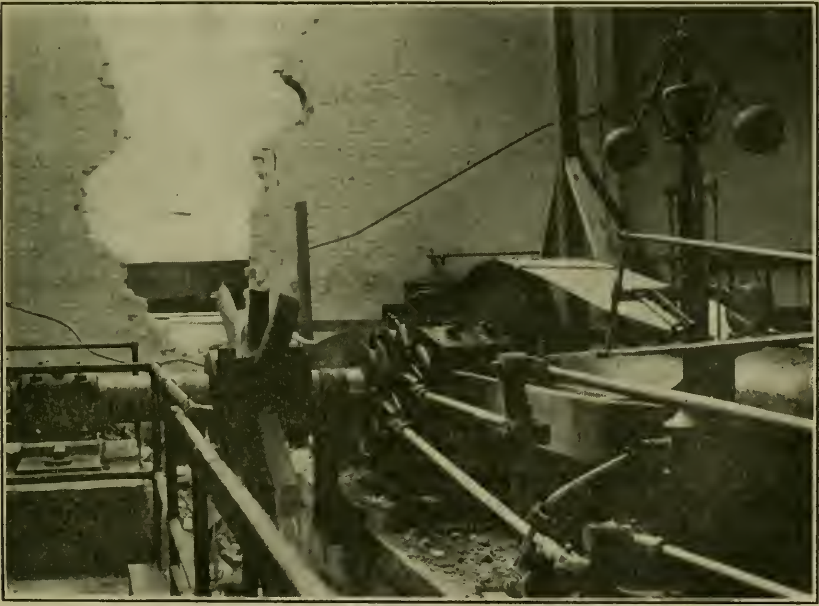
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXV. HARTFORD, CONN., JULY, 1925. No. 7.

COPYRIGHT, 1925, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



FLY-WHEEL EXPLOSION AT LUMBERTON, MISS.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE
PLEASE LET HIM SEE IT.

A Fly-Wheel Explosion at Lumberton, Miss.

A DISASTROUS flywheel explosion occurred at the plant of the Edward Hines Yellow Pine Company at Lumberton, Mississippi, February 11, 1924. The engine over-speeded and the 16 ft. flywheel burst with terrific violence. Large holes were torn in the walls and roof of the engine room and considerable damage was done to the equipment. One large piece of the wheel, weighing approximately one ton, drove its way through the concrete roof and landed about 500 ft. away from the engine site. Another piece almost as large struck the roof and fell back onto the engine bearing, smashing the bearing cap and cracking the frame so badly that a new one had to be procured. Other pieces passed through the brick wall making the hole shown in the cover picture.

The accident occurred at 12:55 P. M. as the engines were being started up at the end of the lunch hour. Three engines had been in operation during the morning, two of which were shut down during the lunch period. The one containing the flywheel that exploded, No. 3, had been left running. After starting up the other two engines, some difficulty was experienced in synchronizing Nos. 3 and 4 and the engineer went over to the switchboard, which was about 35 or 40 ft. away, to assist the switchboard operator. In passing the engines he noted that they were running at normal speeds. The switchboard operator decided to try and synchronize Nos. 2 and 4, and so pulled the switch, taking the load off of No. 3. The engineer, hearing a humming noise, turned to look at the engines and discovered No. 3 was racing at such a terrific speed that he could not see the arms of the wheel. The next moment the wheel exploded.

After the accident an inspection of this engine revealed everything apparently in excellent operating condition. The valve gear, governor and automatic cut-off were all tested and found satisfactory. The only clue to the cause of this accident was furnished by the governor belt, which was in a somewhat oily condition. This probably caused it to slip around the pulley and failed to speed up the governor in proportion to the engine speed. The engineer stated that the governor was turning while the engine was racing, and this fact tends to confirm the above theory as to the cause of the accident.

Fortunately, no one was injured by the explosion. The property loss amounted to approximately $9,900 and was covered by a " Hartford Steam Boiler " policy.

Another flywheel explosion, also resulting from a slipping governor belt and shown in Fig. 1, occurred July 18, 1924, at the Greenville Ice &

Fuel Company's plant of the Carolina Public Service Corporation. The suction valve pocket on an ammonia compressor failed and allowed the valve to drop into the compressor cylinder. The cylinder head was knocked out and the ammonia thus released. The engineer advanced toward the throttle spraying water from a hose into the fumes, and inadvertently wetted the governor belt. The engine immediately speeded to destruction.

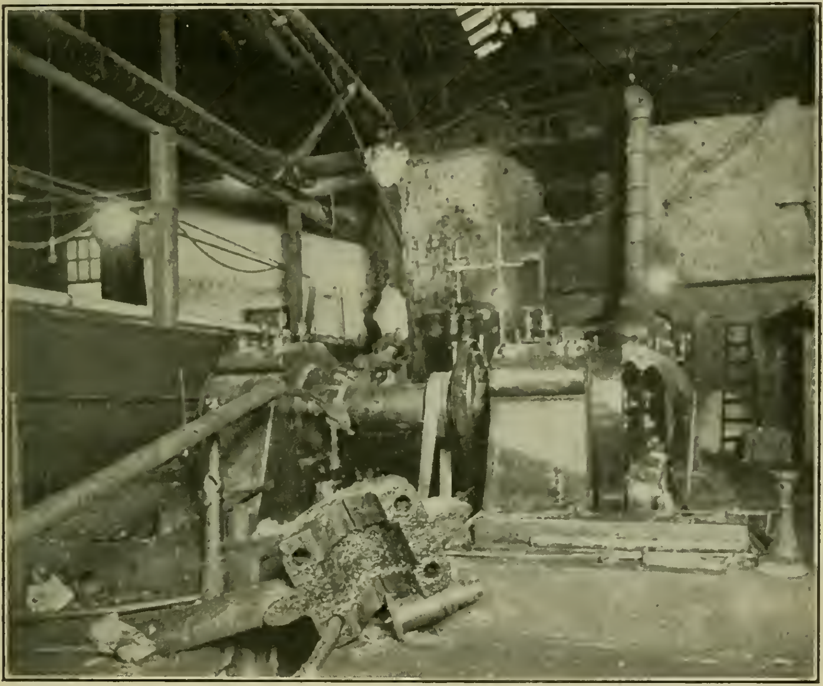


Fig. 1.

The wrecked wheel was part of a 75 ton ice machine and was 16 ft. in diameter and weighed 18 tons. Pieces of it traveled over 300 ft. wrecking, amongst other things, the 10 ft. flywheel on another ice machine, several 12 inch x 12 inch reinforced concrete supports for the condenser tower, as well as some motors, piping, and other equipment.

The property loss was estimated to be $12,000, and the plant was shut down for many days. There was no insurance. The owners were fortunate in having a duplicate machine nearby in an abandoned plant.

The results of still a third accident, the cause of which is also said to have been the failure of the governor belt, are shown in Fig. 2.

This was a 12 ft. flywheel and normally operated at 58 r.p.m. The immediate cause of the engine over-speeding is not apparent, but an examination after the accident revealed that the governor belt was not in good operating condition and undoubtedly ran off of the governor pulley. The belt was oily and slack on the pulleys. In addition, one edge rubbed hard against the engine frame as shown by the worn condition of the edge.

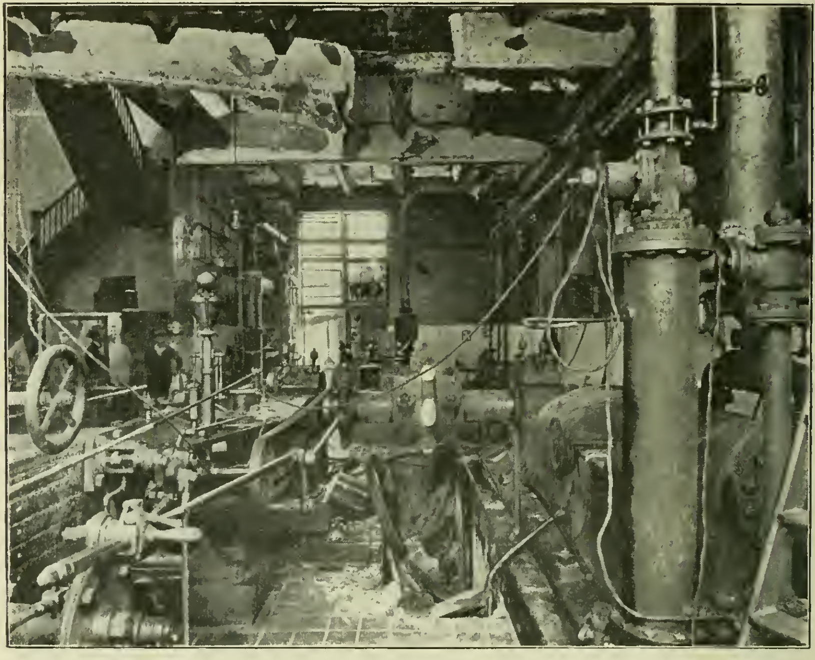


Fig. 2.

This explosion bears another resemblance to the one described immediately above. A large fragment of the wheel struck a 20 inch girder, twisting it out of shape, and then fell back on a 66 inch flywheel on a 75 kw. engine-generator set. Besides wrecking this second flywheel, the shaft of the engine attached to it was bent, the bearing pedestal broken, and the windings of the generator were damaged so that rewinding was necessary. Another fragment struck an ammonia storage tank and ruptured it, causing the loss of about 14 drums of ammonia.

The property loss in this accident is estimated to be $35,000. No insurance was carried.

Foaming and Priming.

JUST what goes on inside of a steam boiler that is in operation is necessarily more or less a matter of conjecture with most of us as few have been fortunate enough to see transparent models in operation. Nevertheless, we know by the effects produced that certain things do take place; whether or not the mechanism of the action is understood is another question. A short time ago one of our leading technical magazines conducted a contest in which a prize was offered for the best answer to the question, " How does the water circulate in a horizontal tubular boiler? " The variety of answers was very likely almost as great as the number of entrants in the contest, and this despite the fact that many of these men had been working with boilers practically all their lives. The correct answer was obtained through observation of a transparent model in operation. As far as we know, the subjects of foaming and priming have not been so minutely investigated, yet they are of vital interest to the operator though perhaps not well understood.

Priming is essentially the carrying off of water by the steam leaving the boiler. It is a serious and even dangerous condition. Priming causes a serious loss of heat in that the water goes off at the same temperature as the steam but its heat is not available for doing work. If the amount of water going over is not very great, the separators will probably remove it. On the other hand, if the quantity is excessive, the separators may not be able to take care of it, and it will find its way to the engines or turbines with perhaps disastrous effect.

A boiler may be caused to prime by any one of many things. It may be due to a high water level, improper circulation, excessive forcing, small disengaging surface, or what is most likely, foaming. With the steam going out of the nozzle at a fairly rapid rate, there is quite a current of steam converging toward the nozzle. Naturally, any drops of water tossed up into this current are likely to be carried along. In ordinary boiling there is a certain amount of water jumping up from the surface as the steam bubbles burst, and anything tending to increase the violence of this action tends towards priming. Some of the probable causes mentioned above are factors of design while others pertain to the method of operation.

Foaming is the formation of bubbles upon the surface due to impurities in the boiler water. These bubbles are, of course, films of water and rise higher and higher from the surface as the foaming continues. If sufficient height is attained, some of the bubbles will be swept into the nozzle with the current of outgoing steam.

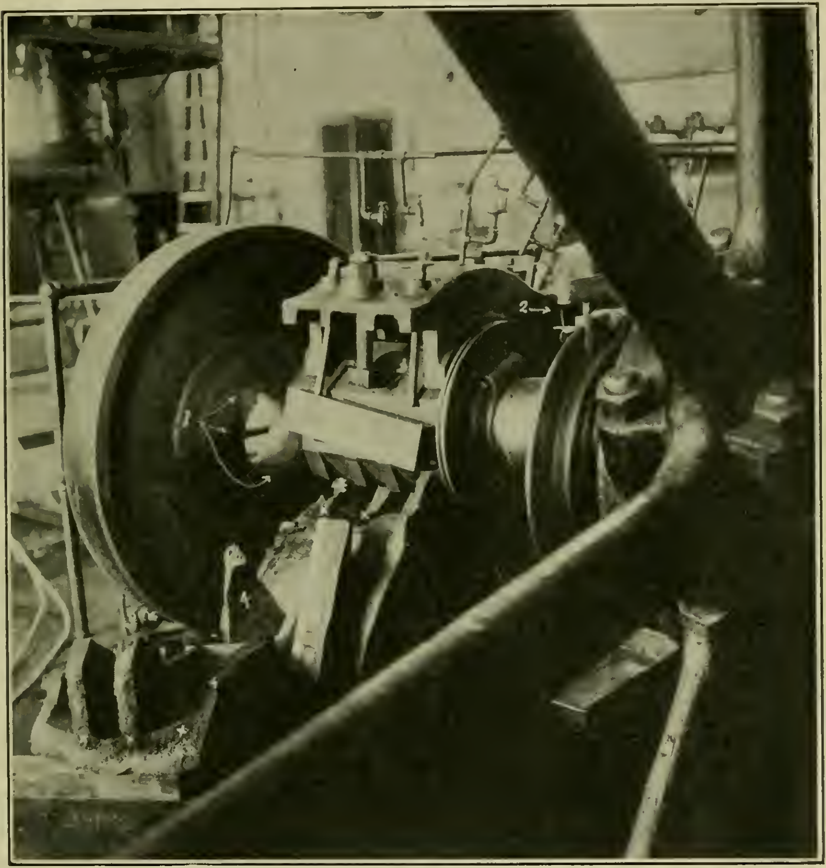
There is another phenomenon which is generally spoken of as "foaming" or is included when speaking of foaming and priming in a general way, and that is an eruptive condition of boiling resulting also from an excessive amount of impurities in the water. It is this action that causes the unsteady, rapidly fluctuating water level so frequently associated with this condition.

THEORY OF FOAMS.

It is known that with comparatively pure water foaming is very slight. It is also known that practically all impurities increase the foaming tendency, though not to the same degree. Because the theory of its production has never been understood, the trouble has been generally laid to special properties of the salts of one or two elements. Sodium has received its share of the blame at the hands of some, while magnesium has been held to be the chief offender by others. It was easy to attribute the action of the soluble material as causing the saponification of organic matter contained in the water, and this undoubtedly does occur in some cases, but not to the extent formerly supposed. The very definite effect of the insoluble materials could not be so easily explained. However, in an article in a recent issue of *Industrial and Engineering Chemistry,* C. W. Foulk points out that practically any substance, when dissolved in water, produces a foaming mixture, but that such foams are not of themselves stable. To make them sustaining, something additional is necessary, such as an insoluble powder. In other words, the foam is produced by the soluable material, but is stabilized or made enduring by the finely divided insoluble material.

This theory is set forth in the above mentioned article and given further authority by quoting from Bancroft's *Applied Colloid Chemistry.* "To get a foam the only essential is that there shall be a distinct surface film, in other words, that the concentration in the surface layer shall differ perceptibly from that in the mass of the liquid. All true solutions will therefore foam if there is a marked change of surface tension with concentration, regardless whether the surface tension increases or decreases . . . . To get a fairly permanent foam the surface film must either be sufficiently viscous in itself or must be stablized in some way. This can be done by introducing a solid powder into the interface."

The author then presents his deductions with reference to boiler feed waters. "On applying these principles to boiler water, it can be said that the fundamental condition of foaming is the presence of substances which concentrate either in the surface or in the mass of the water and thus change the surface tension. Whether there is an increase or a decrease makes no difference. If, however, these substances which change the surface tension do not at the same time have the property of making the film around the bubbles stable, there will be no foam in a practical sense, because the life of the bubbles will be too short — they will burst a moment after forming. It is necessary, then, to distinguish carefully between the two conditions for the formation of foam — (1) the presence of something which, either by raising or lowering the surface tension of the liquid, makes possible the formation of bubbles, and (2) the presence of something which by imparting viscosity to the films will stabilize them — that is, prevent them from bursting immediately after forming. This necessary viscosity can, of course, be produced by the same sub-



Engine Wrecked by Water in Cylinder.

stance which changes the surface tension. Soap, for example, is such a substance and undoubtedly an occasional water is found in which the organic matter has this property, either as it enters the boiler or after modification by the action of the superheated water. In the average boiler water, however, the change of the surface tension is brought about by dissolved sodium salts and the stabilization of the foam by finely divided solid matter. The presence of either one without the other is not sufficient to cause foaming."

The above theory was tested out at the Ohio State University by a great many laboratory boiling tests in which the various factors were changed one at a time and the results noted. These tests, of course, were only on a laboratory scale and therefore the pressures found in steam boiler operation were not approached, but as far as they did go the results all tended to bear out the new theory.

The effect of pressure upon foaming was tested by boiling at varying pressures from below atmospheric pressure up to 37 lbs. gauge, but with no apparent change in results. The effect of temperature was also investigated not only by boiling at various pressures but also by blowing air at room temperature through the foaming mixtures, with the result that foam was produced in every way similar to that produced by boiling.

The most interesting of these experiments were in connection with the foam produced by the various substances when used alone. The sodium salts, for instance, reputed to be serious offenders, were found to produce no foam of any endurance, no matter what the concentration of the solution might be. Likewise, various insoluble, finely divided materials were used with similar results. However, when both a soluble material and an insoluble powdered substance were added, a definite and substantial foam began to form. This increased with increasing concentrations up to a certain point. It is significant that the specific material used made little difference in the amount of foam produced, although powdered boiler scale and limestone were the most effective of the insoluble ingredients. Another very interesting point brought out is that a deficiency of one substance may be overcome by an excess of the other. In other words, the foam increased when additional solid matter was added, regardless of whether it was soluble or insoluble. This consideration alone points to the desirability of keeping the concentration of the boiler water low, as well as freeing it from as much sludge as possible.

PREVENTION OF FOAMING.

The prevention of foaming and possible subsequent priming is of first importance. Under ordinary circumstances a boiler freshly filled should never foam, but after it has been in operation for some time the percentage of impurities has been materially increased, and foaming will soon result unless steps are taken to prevent it. In the article previously mentioned, oil, notably castor oil, was considered as a possible preventive, and investigation revealed that it was very effective in every case in stopping the foaming action. Even though but an insignificant amount of the castor oil was found efficacious, this substance could not be considered for use in steam boilers. Kerosene oil likewise appears to exert a suppressive effect upon foam, even in infinitesimal amounts. It is not uncommon in paper mills, when the foam threatens to overflow onto the sheets, for the machine tender to dip his fingers in kerosene, drain them, and then throw off the residue amidst the foam by violently shaking his hand. The extremely fine spray and small amount of oil thus supplied causes an immediate and preceptible withering of the foam. Kerosene, however, is not a safe substance to use in a boiler room, though an attendant caught with a foaming boiler would undoubtedly welcome something of this kind, a few drops of which would avoid taking the boiler off the line.

The obvious way to prevent foaming is by keeping, as far as possible, all impurities out of the boiler whether they are soluble or insoluble, and by periodically blowing down the boiler. Suggestions on the routine use of the blow-off are given in the article on page 202.

If foaming does occur, check the drafts and cover the fires with fresh coal, or, if oil or gas is used as fuel, shut off the burners. Then shut the stop valve long enough to find the true level of the water. If this is sufficiently high, blow down some of the water in the boiler and feed in fresh water, repeating several times when necessary. If the foaming does not stop, it is best to cool off the boiler, empty it, and seek further for the cause of the trouble.

When a boiler has been foaming, it is quite likely that the foreign matter in the water has been carried into the gauge glass and pressure gauge connections and safety valve. These should all be tested to make sure they are clear.

Value of Antique Plate

Mister Insurance Manager a gage cock blowed out of our boiler and smashed the false teeth of Hank Niswaner our fireman. We can't agree whether to make claim fer property damage or personal injury. Reply in Haste.

The Bottom Blowing of Boilers.

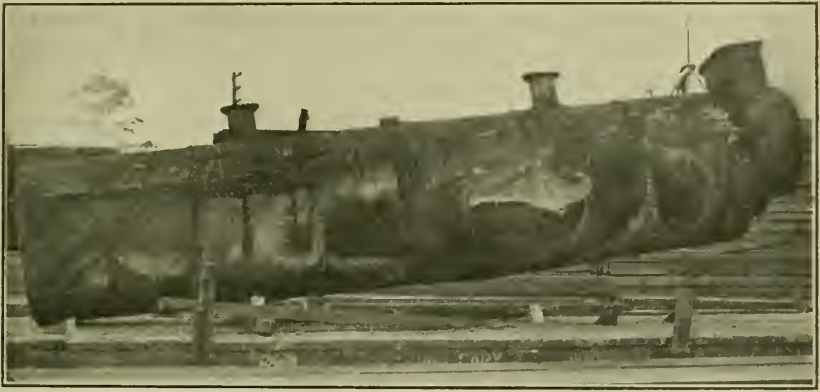
By L. J. Reed, Asst. Chief Inspector, San Francisco Dept.

A LONG and interesting article could be written on this subject but the writer will only touch upon a few of the most important points with the hope that every man in charge of a boiler to whose attention this article may come, will give it some thought and, when the time comes to blow down his boiler, he will realize that he is about to perform a very important duty, one that should not be done thoughtlessly.

In the first place, the time of blowing down is important. The object of this operation is to relieve the boiler of a portion of impure water and as much sludge and soft scale as possible. If the water is circulating rather rapidly in the boiler, the sludge will be stirred up and only the small amount carried in suspension by the water discharged will be disposed of. On the other hand, if it is done after the boiler has been off the line or operating at low rating for some time, the sludge will have had a chance to settle and a much greater proportion of it can be gotten rid of in one blowing. The best time for this operation, therefore, is in the morning before unbanking the fires, or, in the case of boilers operating continuously, at some period of least steam demand as, for instance, immediately after cleaning fires. Another advantage of blowing down while the fire is low, from the point of view of safety, is brought out in a later paragraph.

The frequency of blowing down is also important. This is a variable quantity and depends on the widely fluctuating conditions of water and of duty required of the boiler. When the water is bad and considerable boiler compound is used, or when the duty required of the boiler is heavy, the blow-off should be used more frequently than under normal conditions. Of course, the wasted water contains valuable heat units and blowing down too often "just to make sure" is not economical. The best way to determine the proper frequency is by periodically drawing off a portion and testing the density of the water in the boiler. In general, however, it is recommended that every boiler be blown down at least once every twenty-four hours sufficient to flush out the blow-off pipes. The valve should be opened wide if only for a few moments, but under no circumstances should it be opened or closed rapidly.

One of the most frequent accidents incident to blowing down a boiler is the burning of the metal due to low water. This may be a result of blowing down too much at one time, but more likely is due to failure or inability to close the blow-off valve tightly because it has become clogged with scale. Occasionally it is due to opening the valve on the wrong boiler. With water tube boilers, the higher pressures, small drums and relatively large blow-off pipes result in a considerable drop in the water level, so that care must be taken to prevent uncovering tubes or portions of the drums exposed to the hot gases. This can readily be prevented by stationing an attendant at the gauge glass to give warning when the water gets low in the glass, and no other duties should be performed by either operator until the blow-off valves are closed. Preliminary testing of the gauge glass will insure its accuracy.



Boiler Burned and Ruptured as a Result of Low Water.
The Blow-Off on This Boiler Was Found Open When the Debris Was Being Cleared Away After the Accident.

Should the blow-off valve become clogged, it is well to have an attendant ready to start drawing the fires if the boiler is in operation. Where only one man is on duty in the boiler room, it is advisable to make some provision for subduing the fire before starting to blow down, as one man could not perform all of the necessary duties in case of just such an emergency. When coal is the fuel, the fire may be banked; when oil or gas is the fuel, the burner should be turned off. In saw mills and box factories, sawdust and slabs usually constitute the fuel and as such fires cannot readily be covered or drawn, it behooves the careful man to be doubly careful. Too much reliance, however, should not be placed upon the rapid smothering or extinguishing of the fire to save the boiler should the blow-off valve fail to close, for enough heat would be given up by the setting to badly burn the boiler should the water level get very low. The best practice is to have two valves on the blow-off line and, as pointed out previously, to blow down the boiler before unbanking the fires.

Low water has been caused by opening the valve on the wrong boiler, a mistake to be guarded against. Even the simplest duties in a power plant require thought in their performance.

It is well to again emphasize that all valves in the power plant should be opened and closed slowly. In the case of the blow-off valve, the closing is even more important than the opening, as rapid closing of a water valve causes extreme stresses in the piping due to the ram action of the incompressible water.

When two or more boilers are connected to the same blow-off pipe, if any of the boilers are empty, the valves to the empty ones should be closed and locked to prevent steam blowing back into such boilers with probable fatal results to anyone inside it. When the discharge is into the open, special precautions should be taken to prevent the scalding of any persons who may happen to be near the outlet.

Where surface blow-offs are provided, these may be opened frequently but only for a few moments at a time.

An Efficient Safety Valve.

By Inspector C. B. Bailey, Pittsburgh Dept.

WHAT might have been a very serious accident was narrowly averted a short time ago largely through the Herculean efforts of a safety valve. A road roller, with a locomotive fire box boiler of double riveted butt seam construction and operating at an approved pressure of 150 lbs., was working on a township road. The water in the boiler became low and the engineer started with the machine for a fresh supply. He had just turned the roller crossways in the road and backed into a lane a short distance when, with a roar, the machine became enveloped in flames. It appears that the rear wheels were fitted with large spikes and, in backing off of the road, as these wheels reached the ditch the spikes punctured a high pressure gas line in two places. The engineer's first thought was that a tube had "let go" and so he hastily shut off the steam and jumped from the roller. His clothes were aflame, but he soon extinguished the fire by rolling in a pile of sand. His burns were not serious, although he was laid up for a couple of weeks.

When the cause of the trouble was discovered, it was felt that the best way out would be to open the throttle and let the machine "pull itself out of the fire." However, it was impossible to get near the roller much less the throttle. Different things were used to try and move the throttle, but in vain. The safety valve was working hard, traffic was held up, and people from waiting automobiles stood near watching the cab of the roller burn. The whole machine was still enveloped in flames, the flames shooting ten to twelve feet above the cab. The steam pressure was rising steadily above the approved pressure. The engineer and helper were becoming excited and getting nothing accomplished until someone from a waiting automobile came up and had sufficient presence of mind to suggest a practical way out of the difficulty. It was suggested that the pipe line be cut and pulled away. Accordingly, an axe was procured, the pipe line cut, and the pressure end pulled away through the assistance of a team of horses.

By the time this intense heat had been removed, the water was near the bottom of the glass and the steam pressure had almost reached the 300 lbs. mark. There was a fairly good fire in the furnace and the entire outside of the boiler had been under a forced fire. The safety valve was of the spring type, practically new, and conformed to the latest requirements of the American Society of Mechanical Engineers. It was designed to relieve the excess pressure under forced conditions, but the manner in which this boiler was being forced was too much for the safety value and the pressure rose in spite of its best efforts to keep it down. The engineer remarked that he had never heard a safety valve work so hard and that it was a mighty good thing that it did work so freely. People in automobiles parked near the scene little realized the danger to which they had been exposed.

All boilers should be equipped with safety valves sufficient to relieve them under forced conditions. The valves should be kept in first-class condition and tested at least once a day by hand or steam to make certain that they act properly. Above all things in boiler operation, be sure your safety valve is right.

As Vacation Approaches

I wish I was a rock,
  A sittin' on a hill;
A doin' nothin' all day long,
  But just a sittin' still.
I wouldn't sleep, I wouldn't eat,
  I wouldn't even wash;
I'd just sit still a thousand years
  And rest myself, by gosh!

Some After Effects of Welding on Boilers.

WITH reference to boilers, there is an application of welding which has been generally accepted as a harmless cure for a very annoying condition, and that is the sealing over of leaky girth seams. When the strength of the boiler was otherwise deemed ample, no objection was raised to sealing the leaky places by welding — providing, of course, that no sealing be done on the longitudinal seams — and this Company now has insured many boilers which have received this treatment. An interesting accident of recent occurrence presents evidence that the effect is more far-reaching than has been thought.

Eight years ago a battery of five boilers, all of which were made by a prominent and reliable manufacturer, located in the power plant of a factory developed chronic leaks along the girth seams. It was thought that sealing by welding would most readily solve the problem, and so an acetylene welder was called in. This did not remedy the trouble permanently, however, and shortly after more welding was done, this time by the electric arc method. All five boilers were effectually sealed by more or less of this treatment and gave practically eight years of service without any serious interruptions.

Recently the night watchman at the plant reported having heard a distinct report in the boiler room between 3 and 4 o'clock in the morning but was unable to locate anything wrong. The next day, one of the firemen reported having heard a similar noise between 11:00 A. M. and 12:00 M. Later on the same day upon getting up a few pounds pressure in a boiler that had lain cold, the cause of the mysterious noises was revealed. A circumferential crack was discovered in the solid plate right at the edge of the added metal on the first girth seam. At first it was believed to be a short crack about 12 inches long and subject to patching, but it was found upon investigation to extend so far around that the boiler was immediately condemned.

Realizing that the other four boilers had been treated in a like manner at the same time, some concern was felt for their safety. Internal stresses such as had ruptured the first boiler might also be present in the others, yet there was no ready way of determining this. While the question was still being debated, it was suddenly settled in a decisive manner. Within a month, two of the other boilers suffered a like failure, and under almost exactly the same conditions. Eight years of service had not removed the strains of localized heating and cooling.

An Autogenously Welded Tank Failure at New Orleans.

An autogenously welded tank exploded March 21, 1925, at the plant of the Maltose Laboratories, Inc., New Orleans, La., killing five men and seriously injuring three. The tank was used as a malt mixer in connection with a new process for the canning of a malt mash to be sold for making "near beer." Under the supervision of the inventor, the plant was being started up for the first time when the accident occurred.

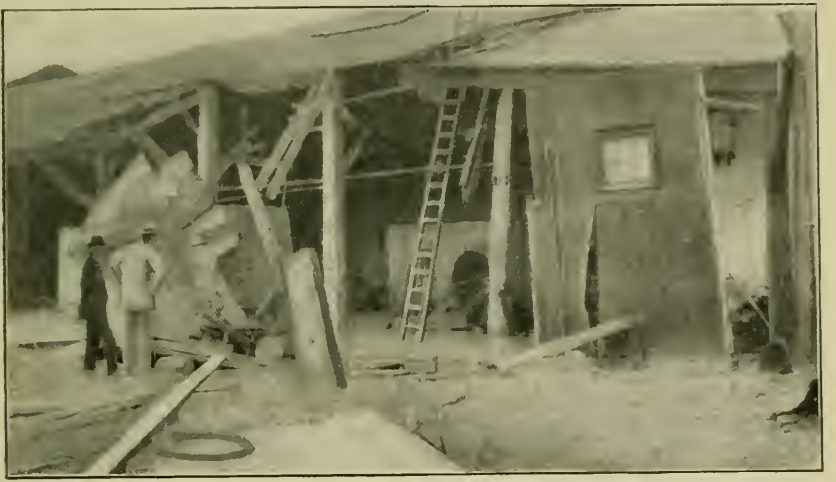
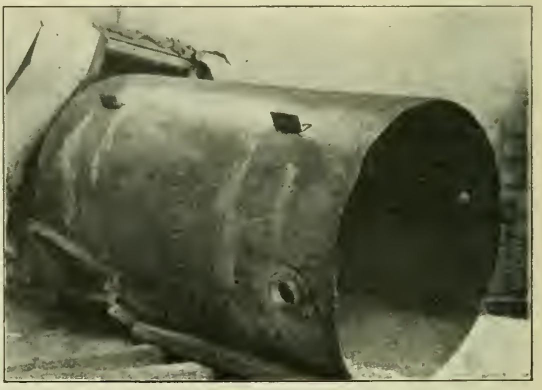


Fig. 1.

The vessel was 71 inches in diameter by 10 ft. long and had cone-shaped heads. The material of both shell and heads was ¼ inch tank steel. A 2 inch shaft ran through the heads of the tank and carried wooden paddles for the mixing operation, the shaft being driven by an electric motor. A 2½ inch pipe connected directly with the boiler supplied the tank with steam for the process. As there was no reducing valve in the line and no safety valve on the mixing tank, it was apparently the intention to regulate the pressure in the latter by varying the pressure in the boiler. At the time of the accident the pressure is said to have been 20 lbs., but as the safety valve on the boiler was set for 100 lbs., there is no assurance, in the excitement that would naturally prevail in starting up a new process, that the pressure did not go higher than 20 lbs.

Eye-witnesses of the accident state that the explosion occurred almost immediately after the signal had been given by the inventor to turn steam into the mixer. One head of the tank was blown completely out and hurled 50 ft. away, tearing a section 100 ft. long out of the side of the galvanized iron building that housed the mixer. The heavy concrete foundation for the mixer was wrecked. Three of the victims were caught under the tank as it was dislodged and were instantly killed. Another one was blown to the roof and hung suspended by his feet until rescued by means of the ladder that is quite prominent in Fig. 1.

Examination of the mixer after the accident revealed the cause of the explosion to be a very imperfect autogenously welded head seam. All seams in the tank, both longitudinal and girthwise, were autogenously welded; but evidently the one that failed was weaker than the others for none of them opened up. The heads were made with a one inch skirt or flange around which eleven ⅜ inch rivets were unequally spaced to hold the head in place while welding. All of these rivets sheared off when the head blew out.



The Mixer After the Accident.

Just how much pressure was supposed to be in the tank when operating is problematical. A short time previous, while arranging for insurance on the boiler, the agent suggested extending the policy to include the mixer but was told that it was not a pressure vessel, that "in fact it will operate under a slight vacuum." As the process was a secret one and as the tank was not connected up at the time, no further inquiry was made. Had it been insured, an inspector would have pointed out the danger of using this mixer as a pressure vessel.

Five men were killed and three injured. The property loss, estimated at $1,500 was small due to the light construction of the building.

Corrosion.

THERE are many good reasons for the growing interest in the problem of corrosion. In the first place, with the enormous use of steel in modern industries and a rate of production for this country alone of the order of 40,000,000 tons of ingots per year, the destruction of property by corrosion is beginning to run into sums so enormous as to stagger imagination. Taking figures presented a couple of years ago by Sir Robert A. Hadfield on losses by corrosion and translating them into terms of dollars, it would appear that the annual toll taken by this one evil may be legitimately estimated at $900,000,000.

The second reason why engineers are working more and more on this problem is the growing conviction that these enormous losses are really entirely unnecessary and that somewhere there is a solution for it. In fact, partial solutions have been already discovered, and it is merely a question of finding a practical one applicable to ordinary engineering materials. Had chromium been as common, for example, as sand, the problem would have been solved. From the work of Brearley, Haynes, Becket, and others it is known that chromium present in steel to the extent of from 10 to about 30 per cent inhibits corrosion most effectively and makes steel resistant not only to ordinary atmospheric influences but even to such powerful corrosive agents as boiling sulphuric acid. The trouble is that chromium is one of the uncommon though not rare elements, and the cost of high-chromium steel is entirely too high for mere ordinary uses.

It has also been found that small amounts of copper, say, 0.5 per cent, materially increase the resistance of steel to mild corrosive agencies. Investigators are also obtaining more and more information on such matters as corrosion in boilers and condensers, and some work has been successfully done abroad in the direction of preventing corrosion of boiler tubes by establishing an electrical potential opposite to that producing the corrosive effects.

Furthermore, more and more material is being collected on the effect of protective coatings and paints where such can be applied, as, for example, in bridge work. A railroad in the United States has developed a very simple method for giving a protective coat to its rails, which is done at very small cost and is said to give appreciable results.

Of late considerable work has been done on the production of pure electrolytic iron, " pure " in this case meaning something of the order of 99.99 per cent metallic iron, the remainder being apparently occluded hydrogen. Such iron, which through the exigencies of the process itself is produced in tube form, appears to be highly resistant to corrosion and may become commercially important as soon as the details of manufacture are properly developed and provided the subject of costs finds a satisfactory solution.

By employing microscopic investigation of corroded metal together with chemical analysis, an increasingly clear insight into the mechanics of corrosion itself is being obtained, and apparently it is merely a matter of time until phenomena of corrosion are properly classified and a remedy for them found either in the methods of producing materials not subject to corrosion or in varying the conditions of service so as to inhibit corrosion entirely, or, at least, materially delay it.

From this point of view it may be of interest to see what the chemical industries have done. Having to handle corrosive liquids such as diluted acids, alkalies, etc. the chemical industries were particularly interested in finding materials that would give good service without being excessively expensive. Among such materials which are giving excellent service now may be mentioned the high-silicon irons known under the trade names " duriron," " tantiron," etc. Only a few of these are applicable to constructions used in mechanical engineering, but they indicate what has been done and give an insight into what can be done with proper application. One of the great difficulties of many constructions in mechanical engineering is that they are exposed simultaneously to corrosive agencies and high temperatures, so that oxidation or scaling goes on simultaneously with other forms of corrosion, such as, for example, in the case of grate bars. It has been found, however, that a suitable treatment, such as impregnation of the surface skin with aluminum or chromium, which form alloy films with the iron, increases the life of the article to quite a material extent. This is somewhat in line, though done at higher cost, with similar applications of lead, and especially zinc, to protect metal surfaces, and differs from them in that it works at very much higher temperatures.

It should be clearly remembered, however, that, contrary to the somewhat general impression, iron alloys are not the only ones subject to corrosion, and, for example, the investigation of the U. S. Bureau of Mines on corrosion due to mine waters has shown that many brasses and bronzes stable under ordinary atmospheric conditions rapidly corrode when exposed to more powerful agencies.

The foregoing would show that the problem of corrosion has already become one of very noteworthy economic importance and that it is being attacked vigorously and from many angles. It has been the experience of the past that when such a problem becomes really important, some solution for it is usually found, and this solution may be expected to happen in the case of the " demon corrosion," as it is fondly called by makers of non-corrosive materials.— *Mechanical Engineering.*

Caught in the Separator.

HOLD ER, NEWT SHES AREARIN'
WHUTS TH' FUSS?
YOU SAY THATS AN' AWFUL BLAST?
NO-NO- I SAY THIS JOB IS HER LAST!
STANLEY NEA SERVICE
SAM WHITE'S DAUGHTER LASSITUDE AND A LARGE PORTION OF THE KITCHEN STOVE WERE BLOWN THROUGH THE WEST WALL, WHEN THE HOT WATER BOILER BLEW UP AT THE CENTRAL HOTEL TODAY-

Courtesy of the N. E. A. Service.

No Change.

Two young men were having a heated argument over a problem which needed a great deal of mental calculation.

"I tell you," said one, "that you are entirely wrong!"

"But I am not!" replied the other.

"Didn't I go to school, stupid?" almost roared the opponent.

"Yes," was the calm reply, "and you came back stupid." That ended it.

Gentle Reminder.

Mr. Smith (as Margie shifts gears) — "That reminds me — I want to stop at the boiler factory."

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, JULY, 1925.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

AUTOMOBILE accidents continue to occur with distressing frequency, so much so that seldom a day passes that the results of one or more are not in evidence. The cause is not simply our mania for speed and more speed but really because the entire control of each machine is in the hands of a human being. It is left entirely to his judgment and skill, both of which are often poorly developed, to guide as well as to start and stop. The safety of the railroads is greatly enhanced by the division of these functions, the guiding being largely automatic, a fact apparently not generally appreciated judging by the revival of the urban bus with the additional exacting duty of collecting fares that is imposed upon the operator. Yet in spite of this division of functions, of highly trained personnel, and eleborate schedules, occasional railroad wrecks do occur and they can usually be traced to a slip on the part of some one of the operators.

Stationary engines are not hand controlled. Automatic governors are placed upon them to immediately compensate for any variation in load between zero and full capacity. This device never sleeps, has no mental lapses, is not lethargic — so long as it is kept in good condition. But it must be kept in good operating condition, and it is here that the human factor enters with all its weaknesses just as it must in every machine. Without a mind of its own nothing can be indefinitely autonomous. That the part played by the attendant, though less direct, is vital is shown by the three accidents recorded in the first article in this issue. Apparently slight irregularities in the operation of the governor in each instance rendered it unable to respond.

Data on Aqueous Ammonia Solutions.

THE complete understanding of the operation of the absorption ammonia refrigerating machine necessitates a knowledge of the following:

(a) The total vapor pressures of aqueous ammonia solutions over the whole range of temperature and concentration covered in the machine.

(b) The partial vapor pressures exerted by the separate constituents in the vapor above aqua ammonia inside of the same range.

(c) The heats of solutions of various aqua ammonia vapors in aqua ammonia of various concentrations at the different temperatures.

Although the thermodynamic properties of pure ammonia itself have been very accurately determined experimentally, the corresponding properties of aqueous ammonia solutions have received relatively little attention; and very little has been done towards the determination of the total and partial vapor pressures of aqueous ammonia solutions. Such figures as have been up until now available are limited in range, and this reduces very greatly their practical importance for the purposes of the engineer.

The determination and calculation of the total and partial vapor pressures of aqueous ammonia solutions, and their application to the absorption ammonia process illustrated by a concrete example, are the subjects which are dealt with in Bulletin No. 146 of the Engineering Experiment Station of the University of Illinois, entitled *The Total and Partial Vapor Pressures of Aqueous Ammonia Solutions.*

Copies of Bulletin No. 146 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Illinois.

MIGHT GO EITHER WAY.

Anxious Old Lady (on river steamer). I say, my good man, is this boat going up or down?

Surly Deckhand. Well, she's a leaky old tub, ma'am, so I shouldn't wonder if she was going down. Then, again, her b'ilers ain't none too good, 'n she might go up.—*Pittsburgh Press.*

Personal.

It is with pleasure that we announce the appointment, effective April 1st, 1925, of William E. Glennon as Chief Inspector of our Cincinnati Department to succeed the late Walter Gerner.

Mr. Glennon was born near Canton, Ohio. His early engineering experience was primarily in the operation of power plants in the cement industry. During the World War he was with the United States Shipping Board at the plant of the New York Ship Building Company, Camden, N. J.

Mr. Glennon began with this Company as an inspector in the Cleveland Department and in 1923 was appointed Directing Inspector of that Department, a position which he filled with marked success, resulting in his appointment as Chief Inspector at Cincinnati.

Obituary.

After a brief illness, Walter Gerner, Chief Inspector of our Cincinnati Department, died at his home in Cincinnati on Saturday, April 4th, 1925.

Mr. Gerner was born in London, England, in 1870 and was educated in the schools of that country. He first engaged in work as a marine engineer, advancing through the various grades to that of chief engineer of trans-Atlantic vessels, including in the duties of the latter position the supervision of construction and repair of the vessels of the line with which he was connected.

Mr. Gerner came with this Company in October, 1902, as an inspector in the Chicago Department. He was later transferred to the Cincinnati Department when that department was organized and was appointed Chief Inspector in December 1911.

Walter Gerner.

Rather taciturn by nature, Mr. Gerner was an energetic, conscientious and painstaking worker. Characterized as a thorough engineer, he carried on the work of his Department in a most approved manner.

By the death of Mr. Gerner the Company loses a thoroughly experienced and capable engineer.

Summary of Boiler Explosions For 1923 and 1924

SUMMARY FOR 1923

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	97	13	19	32
February	100	8	17	25
March	73	11	20	31
April	49	19	29	48
May	45	13	23	36
June	31	12	15	27
July	44	13	37	50
August	60	11	46	57
September	44	12	43	55
October	80	13	37	50
November	71	21	37	58
December	61	4	4	8
Total for 1923 .	755	150	327	477

SUMMARY FOR 1924

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	105	10	50	60
February	85	20	27	47
March	70	6	15	21
April	47	4	21	25
May	50	7	21	28
June	38	13	10	23
July	29	8	5	13
August	32	21	22	43
September	56	13	29	42
October	76	6	15	21
November	86	5	31	36
December	106	8	11	19
Total for 1924 .	780	121	257	378

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF AUGUST, 1924.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
425	1	Autogenously welded patch blew out of tank	1		Van Wagenen & Schickhaus	Packing House	Newark, N. J.
426	3	Hot water heater exploded			O. E. Pore	Residence	Toledo, Ohio
427		Boiler of locomotive exploded	1	3	Wheeling & Lake Erie R. R. Co.	Railroad	Harmon, Ohio
428		Boiler ruptured			Coale Muffler & Safety Valve Co.	Safety V. Mfgrs.	Baltimore, Md.
429	4	Section of heating boiler cracked			Harris Perilstein	Wholesale House	Phila., Pa.
430	6	Tube ruptured			American Steel & Wire Co.	Wire Works	Donora, Pa.
431		Steam pipe burst		1		Borax Works	San Francisco, Cal.
432	10	Safety valve on air tank ruptured			Service Ice Company	Ice Plant	Indianapolis, Ind.
433	12	Boiler exploded	1	5	Central of Georgia R. R. Co.	Railroad	Dadeville, Ala.
434		Boiler exploded	3	3	Samuel Watts	Cheese Factory	Bishop's Mills, Ont.
435	13	Four headers ruptured			Samuel Merritt Hospital	Hospital	Oakland, Calif.
436	14	Boiler bulged and ruptured			Chapman-Storm Lumber Co.,	Sawmill	Morgan City, La.
437	16	Tube ruptured			C. H. Wheeler Mfg. Co.	Foundry	Philadelphia, Pa.
438	18	Blow-off pipe failed		1	Home Ice Factory	Ice Plant	San Antonio, Tex.
439		Tube ruptured			Crex Carpet Co.	Carpet Factory	St. Paul, Minn.
440		Steam pipe burst	1		Associated Oil Co.	Refinery	Martinez, Calif.
441		Tube ruptured		1	Toledo Grain & Milling Co.	Flour Mill	Toledo, Ohio
442	19	Vulcanized head blew off	1		Hood Rubber Co.	Rubber Works	Watertown, Mass.
443		Tube ruptured			West Penn Steel Co.	Tin Plate Mill	Brackenridge, Pa.
444	20	Five sections heating boiler cracked			General Motors Corporation	Automobile Mfgrs.	Detroit, Mich.
445	21	Tube ruptured			Monument Mills	Cotton Mill	Housatonic, Mass.
446	22	Tube ruptured			Lehigh Portland Cement Co.	Cement Factory	Mason City, Iowa
447	23	Mud drum exploded			Sutherland Flour Mills Co.	Flour Mill	Cairo, Ill.
448		Firebox collapsed			Bade Lumber Co.	Lumber Mill	Portland, Ore.
449	25	Jacketed kettle ruptured			Fanny Farmer Candy Shops, Inc.	Candy Factory	Rochester, N. Y.
450		Section of heating boiler cracked			The Country Club	Club House	Brookline, Mass.
451		Boiler of locomotive exploded	2			Railroad	River Curve, Ky.
452	26	Boiler exploded			Hardie Tynes Mfg. Co.	Engine Builders	Birmingham, Ala.

453	27	Section of heating boiler cracked			H. J. Bockenhoff	Stores	Des Moines, Ia.
454	28	Autogenously welded ammonia tank exploded	11	8	South Side Grocery	Store	Des Moines, Ia.
455	29	Throttle valve exploded (#2 Engine)			City of Greenville	Lgt. & Water Pt.	Greenville, Tex.
456	30	Throttle valve exploded (#1 Engine)			City of Greenville	Lgt. & Water Pt.	Greenville, Tex.

MONTH OF SEPTEMBER, 1924.

457	1	Two sections heating boiler cracked			Church of the Nativity	Church	Willimansett, Mass
458		Section of heating boiler cracked			Chas. M. Prince	Residence	Philadelphia, Pa.
459	2	Boiler exploded	1	5	Allen Huffman	Cider Mill	St. Paris, Ohio
460	3	Two sections heating boiler cracked			Board of Education	School	Rochester, Pa.
46		Superheater tube ruptured			Hodge-Hunt Lumber Co.	Lumber Mill	Hodge, La.
462		Two headers cracked			Louisiana Ice Co.	Ice Plant	New Orleans, La.
463	6	Boiler exploded		2	Conrad Auth Farm	Farm	Ladd, Ill.
464	7	Boiler bulged & ruptured			Prouty Lumber & Box Co.	Lumber Mill	Warrenton, Ore.
465		Tube ruptured			Stamford Gas & Elec. Co.	Power Plant	Stamford, Conn.
466	8	Boiler exploded		2	Gregory Gin	Cotton Gin	Greenville, Ala.
467		Six headers cracked			Nonpareil Laundry Co. Inc.	Laundry	New Haven, Conn.
468	9	Two sections heating boiler cracked			S. N. Fisher	Apts. & Stores	Chicago, Ill.
469	10	Section of heating boiler cracked			Edw. A. Rice	Residence	S. Deerfield, Mass.
470		Section of heating boiler cracked			San Antonio County Club	Club	San Antonio, Tex.
471	11	Section of heating boiler cracked			Leominster Savings Bank	Bank	Leominster, Mass.
472		Two sections heating boiler cracked			C. F. Mattlage & Son	Fish Pier	Gloucester, Mass.
473	12	Tube ruptured			Schneider & Maguire	Cotton Gin	L. Providence, La.
474		Boiler ruptured			Hardwood Mill	Lumber Mill	Magnolia, Ark.
475	14	Boiler exploded	5	3	Henderson Canning Co.	Canning Plant	Henderson, Md.
476		Boiler of locomotive exploded			A. T. & S. F. R. R. Co.	Railroad	Ellinwood, Kan.
477	15	Section of hot water heater cracked			Ira N. Arnold	Apt. House	Houston, Texas
478		Nine headers cracked			Crown-Williamette Paper Co.	Paper Mill	Floriston, Calif.
479		Boiler ruptured			C. H. Dutton Co.	Boiler Factory	Kalamazoo, Mich.
480		Two sections heating boiler cracked			Tilton School	School	Tilton, N. H.
481		Three sections heating boiler cracked			Est. of Kaskel Solomon	Offices & Stores	Pittsburgh, Pa.
482		Section of heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Glens Falls, N. Y.
483		Section of heating boiler cracked			C. & E. Motor Co.	Garage	Indiana, Pa.
484	16	Boiler bulged and ruptured			Keene & Wolfe Oil Co.	Oil Refinery	Houston, Texas
485		Valve ruptured	1	2	Royal Oak Canning Factory	Canning Plant	Delmar, Del.
486		Section of heating boiler cracked			Board of Education	School	Pittsburgh, Pa.

MONTH OF SEPTEMBER, 1924 (Cont'd.)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
487	17	Three sections heating boiler cracked			Professional Realty Co.	Office Bldg.,	Charlotte, N. C.
488	18	Boiler exploded		1	Henry Devore	Threshing Outfit	Junction Cy., Kan.
489		Fitting ruptured		1	Danciger Oil Co.		Spencer, La.
490	19	Section of heating boiler cracked			M. H. Condron	Apt. House	Pittsfield, Mass.
491	20	Section of heating boiler cracked			First National Bank	Bank	Blairsville, Pa.
492	22	Digester exploded	3	4	New York & Pa. Co.	Pulp & Paper Mill	Lock Haven, Pa.
493	24	Boiler exploded	2		Andrew Jesperson		Buffalo, N. D.
494		Boiler exploded		1	Allen Weir	Tractor	Mt. Carmel, Ill.
495		Section of heating boiler cracked			Vimo Realty Corpn.	Apt. House	New York, N. Y.
496	25	Blow-off pipe fitting failed			Sumter Hardwood Co.	Sawmill	Sumter, S. C.
497		Crown sheet of locomotive failed		2	Whitmer-Parsons Pulp & Lumber Company.	Pulp & Lumber Mills	Horton, W. Va.
498	26	Rotary boiler exploded			Lincoln Paper Mill	Paper Mill	Merritton, Ont.
499		Boiler exploded		1	Illinois Central R. R. Co.	Railroad	Nonconnah, Tenn.
500		Four sections heating boiler cracked			R. C. Taylor Estate	Real Estate	Worcester, Mass.
501	27	Tube failed			Pennington Ldry. & Cleaning Co.	Laundry	Schreveport, La.
502		Blow-off pipe failed (2nd accident)			Sumter Hardwood Co.	Sawmill	Sumter, S. C.
503		Boiled exploded		5	Sargossa Mining Co.	Mine	Jasper, Ala.
504		Boiler ruptured			Keith Sons & Co., Ltd.	Cotton Gin	Keithville, La.
505	28	Boiler exploded			Congregation Shomri Shabath	Synagogue	Passaic, N. J.
506		Seven tubes pulled out of drum			Carnegie Steel Co.	Steel Plant	Clairton, Pa.
507		Section of heating boiler cracked			Elizabeth Finnigan	Apt. House	Waterbury, Conn.
508	29	Section of heating boiler cracked			Forsyth Apartment Co.	Apt. House	Savannah, Ga.
509		Section of heating boiler cracked			Bray Hotel	Hotel	Kansas City, Mo.
510		Fitting on ammonia line failed			City Ice & Coal Co.	Refrigerating Plt.	Grenada, Miss.
511		Tube failed			Consolidated Textile Corp'n.	Cotton Mill	Henderson, Ky.
512		Manhole flange cracked			Peek & Lawson	Cotton Gin	Boxelder, Tex.

MONTH OF OCTOBER, 1924.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
513	1	Fitting on main steam line failed			American Printing Co.	Cotton Mill	Fall River, Mass.
514		Hot water heater exploded			City National Bank	Bank	Holyoke, Mass.

515		Three sections heating boiler cracked			Ferrigno & Perrone	Apt. House	Hartford, Conn.
516		Two sections heating boiler cracked			Reifers Furniture Co.	Store	La Fayette, Ind.
517		Section of heating boiler cracked			Loews, Inc.	Theatre	New York, N. Y.
518	2	Air tank exploded				Church	Richmond, Ky.
519		Boiler exploded	3			Threshing Mch.	Steele, N. D.
520		Throttle valve ruptured			Hincher Mfg. Co.	Coat Hanger Fct'y	Washington, Ind.
521		Header cracked			San Francisco Laundries Ass'n	Laundry	San Francisco, Cal.
522	3	Tube ruptured			Alex Smith & Sons Carpet Co.	Carpet Factory	Yonkers, N. Y.
523		Tube ruptured			International Milling Co.	Flour Mill	Davenport, Ia.
524		Boiled exploded		1	Derby Callahan	Oil Well	Newton, Kansas
525		Crown sheet bagged and ruptured			Bessemer Limestone & Cement Co.	Cement Plant	Bessemer, Pa.
526		Section of heating boiler cracked			D. of I. Home for Aged	Home	Newark, N. J.
527		Section of heating boiler cracked			M. M. Goldstein	Apt. House	Atlanta, Ga.
528		Twelve headers cracked			Spreckels Sugar Co.	Sugar Mill	Spreckels, Cal.
529	4	Section of heating boiler cracked			Hotel Iroquois	Hotel	San Francisco, Cal.
530		Three sections heating boiler cracked			LeRoy Shirt Co.	Shirt Factory	Norwalk, Conn.
531		Tubes pulled out of drum			Morton Salt Co.	Salt Plant	Grand Saline, Tex.
532		Boiler exploded		3		Sawmill	Great Falls, Va.
533		Boiler exploded		1	Isaac Brainerd	Turkish Bath	Bayonne, N. J.
534	5	Crown sheet collapsed			The Foundation Co.	Contractors	Twin Branch, Ind.
535	7	Three sections heating boiler cracked			V. La Rosa	Macaroni Fct'y	Brooklyn, N. Y.
536		Section of heating boiler cracked			St. John's School	School	Deep River, Conn.
537	8	Section of heating boiler cracked			School District	School	Hastings, Nebr.
538		Section of heating boiler cracked			Louis Grechewsky	Stores & Office	Haverhill, Mass.
539	9	Two sections of heating boiler cracked			Index Printing Co.	Printing Office	Atlanta, Ga.
540	10	Two sections of heating boiler cracked			Hunt-Spiller Mfg. Corp'n	Foundry	So. Boston, Mass.
541		Four sections heating boiler cracked			Harry G. Webster, Agent	Apts. & Stores	Springfield, Mass.
542		Header cracked			Eastman Kodak Co.	Photo Material	Rochester, N. Y.
543		Boiler exploded		1	E. Lauderdale	Cotton Gin	La Salle, Tex.
544	11	Boiler exploded	1	2	Ellison Lovell	Lumber Mill	Monticello, Miss.
545	12	Boiler ruptured			Pond's Laundry	Laundry	Wichita Fls., Tex.
546		Two sections heating boiler cracked			Louis B. Mayer	Mercantile Bldg.	Los Angeles, Cal.
547	13	Section of heating boiler cracked			Karelitz & Bernahtan	Business Block	Peabody, Mass.
548	14	Seven sections heating boiler cracked			City of New Bedford	Public School	New Bedfd., Mass.
549		Boiler ruptured			Seymour Hotel Co.	Hotel	Los Angeles, Cal.
550	15	Tube ruptured			Niles Tool Works Co.	Machine Tl. Wks.	Hamilton, Ohio
551		Blow-off pipe failed		1	Fair Oaks Stave Co.	Cooperage Plant	Fair Oaks, Ark.
552		Boiler bulged and ruptured			Bledsoe Gin Co.	Cotton Gin	Bogota, Tenn.
553		Section of heating boiler cracked			A. B. Bement	Apt. House	Terre Haute, Ind.

MONTH OF OCTOBER, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
554	16	Section of heating boiler cracked			Friedman-White Realty Co.	Apt. House	New York, N. Y.
555		Air tank exploded			Strickland Garage	Garage	Med. Lodge, Kan.
556	17	Boiler exploded	2		Empire Pipe Line Co.		Henryetta, Okla.
557		Boiler ruptured			J. R. Phillips	Planing Mill	Eupora, Miss.
558	18	Three sections heating boiler cracked			D. A. Cushman Realty Co.	Apt. House	New York, N. Y.
559	19	Section of heating boiler cracked			M. H. Condron	Apartment Block	Pittsfield, Mass.
560		Sixteen tubes bulged and ruptured			Keystone Power Corp'n	Power Plant	Ridgway, Pa.
561	20	Section of heating boiler cracked			Children's Aid Society	School	New York, N. Y.
562		Section of heating boiler cracked			Thomas Martindale	Garage	Philadelphia, Pa.
563	21	Two sections heating boiler cracked			Wolfe, Sayer & Heller, Inc.	Merchants	New York, N. Y.
564		Tube collapsed			Ajax Coal & Mining Co.	Coal Mine	Johns, Ala.
565		Tube ruptured			Byrant Paper Co.	Paper Mill	Kalamazoo, Mich.
566	22	Air compressor exploded		3		Contractor	New York, N. Y.
567		Section of heating boiler cracked			Atlantic Basin Iron Wks.	Iron Works	Brooklyn, N. Y.
568		Section of heating boiler cracked			Murphy Investment Co.	Apt. House	Norfolk, Va.
569		Four sections heating boiler cracked			Y. W. C. A.	Y. W. C. A. Bldg.	Springfield, Mass.
570	24	Two sections heating boiler cracked			Wausau Club	Club House	Wausau, Wis.
571		Header cracked			Phoenix Hotel Co.	Hotel	Lexington, Ky.
572		Steam radiator exploded		2	Russell Packing Co.	Packing House	St. Louis, Mo.
573	25	Crown sheet collapsed			Beck & Wallace	Stone Quarry	Van Lue, Ohio
574		Section of heating boiler cracked			Purdue University	University	LaFayette, Ind.
575		Two sections heating boiler cracked			Hunting Bros.	Warehouse	E. Hartford, Ct.
576		Two sections heating boiler cracked			Millville Mfg. Co.	Mill & Office Bldg.	Philadelphia, Pa.
577	26	Five sections heating boiler cracked			Children's Aid Society	School	New York, N. Y.
578	28	Section of heating boiler cracked			St. Louis Amusement Co.	Theatre	St. Louis, Mo.
579		Boiler ruptured			Wm. Craig Canning Co.	Canning Factory	Ogden, Utah
580	29	Steam pipe burst		1	Central Indiana Gas Co.	Gas Plant	Anderson, Ill.
581		Header cracked			Philadelphia Quartz Co.	Chemical Plant	Kansas City, Kan.
582		Section of heating boiler cracked			Katz Underwear Co.	Textile Mill	Honesdale, Pa.
583		Section of heating boiler cracked			Louise K. Slusher	Apt. House	San Francisco, Cal.
584		Section of heating boiler cracked			Warehouse Land & Imp. Co.	Printing Office	San Francisco, Cal.
585	30	Section of heating boiler cracked			Samuel Schlinger	Apts. & Stores	Denver, Colo.

586		Section of heating boiler cracked			Loew's, Inc.	Theatre	New York, N. Y.
587	31	Tube ruptured			Lackawanna & Wyoming Valley Power Co.	Power Plant	Scranton, Pa.
588		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.

MONTH OF NOVEMBER, 1924.

589	1	Section of heating boiler cracked			Sheffield Scientific School	College	New Haven, Conn.
590		Section of hot water boiler cracked			Alice Perels	Apt. House	San Francisco, Cal.
591	2	Steam pipe ruptured			American Construction Co.	Tug "Albatross"	Sandusky, Ohio
592	3	Valve on steam main burst			Forty-two Broadway	Office Bldg.	New York, N. Y.
593	4	Tubes pulled out of drum			Brown Paper Mill Co., Inc.	Pulp & Paper Mill	Monroe, La.
594		Three sections heating boiler cracked			Pennzoil Co.	Oil Refinery	Vernon, Cal.
595		Hot water tank exploded			L. H. Naveau	Residence	Toledo, Ohio
596	5	Tube rupture			Dixie Milling Co.	Flour Mill	Burlington, N. C.
597	6	Tank exploded		3	U-Glue Co.		Long Island City,
598		Tube ruptured			Illinois Brewing Co.	Brewery	Socoro, N. M.
599	7	Boiler exploded		1	Independent Tire Co.	Vulcanizing Plt.	Memphis, Tenn.
600		Steam pipe ruptured	1	3	The Portner	Apartment House	Washington, D. C.
601		Air tank exploded		3	Edwards Mfg. Co.		Cincinnati, Ohio
602	8	Section of heating boiler cracked			Kraftsow & Titelman	Mercantile Bldg.	Philadelphia, Pa.
603		Section of heating boiler cracked			Bernhard Greeff	Apartment House	New York, N. Y.
604		Two sections heating boiler cracked			Michael J. Sullivan	Apartment House	New York, N. Y.
605		Tube ruptured		1	Mississippi Power & Light Co.	Power Plant	Columbus, Miss.
606	9	Fitting in main steam line failed			J. W. Davis Co.	Green House	Terre Haute, Ind.
607	10	Section of heating boiler cracked			Willys-Overland Co.	Automobiles	Pittsburgh, Pa.
608		Two sections heating boiler cracked			J. M. Barker	Office Bldg.	Bristol, Tenn.
609		Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
610	12	Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
611	13	Header cracked			American Gas & Electric Co.	Power Plant	Marion, Ind.
612		Boiler exploded		4	W. E. Belcher	Sawmill	Jericho, Miss.
613		Steam pipe ruptured		2	American Steel & Wire Co.	Steel Plant	Worcester, Mass.
614		Section of heating boiler cracked			Paterson Mutual Hosiery Mills	Hosiery Mill	Philadelphia, Pa.
615	14	Section of heating boiler cracked			No. Grant Conso. School Dist.	School	Ames, Iowa
616	15	Matrix drying steam-table exploded		1	Edwardsville Intelligencer	Newspaper Office	Edwardsville, Mo.
617		Four sections heating boiler cracked			Capitol Theatre	Theatre	Braddock, Pa.
618		Tube ruptured			Newport News Shipbuilding and Dry Dock Co.	Shipyard	Newp't News, Va.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1924

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$312,885.77
Real Estate	255,000.00
Mortgage and collateral loans	1,797,000.00
Bonds and stocks	9,830,809.50
Premiums in course of collection	1,114,552.34
Interest Accrued	145,614.56
Total assets	$13,455,862.17

LIABILITIES

Reserve for unearned premiums		$5,897,736.62
Reserve for losses		258,782.17
Reserve for taxes and other contingencies		559,988.34
Capital stock	$2,500,000.00	
Surplus over all liabilities	4,239,355.04	
Surplus to Policyholders,		**$6,739,355.04**
Total liabilities		$13,455,862.17

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, Chairman Board of Trustees United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Vice-President The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President the Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President The Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.
WM. R. C. CORSON, Vice-President The Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.
SAMUEL M. STONE, President The Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, President The Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866 Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, Ga.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abel Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn.,	W. G. Lineburgh & Son, General Agents.
404-405 City Savings Bank Bldg.	A. E. Bonnet, Chief Inspector.
CHICAGO, Ill.,	P. M. Murray, Manager.
209 West Jackson B'l'v'd	J. P. Morrison, Chief Inspector.
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio,	W. E. Gleason, Manager.
First National Bank Bldg.	W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chesnutt, Manager and Chief Inspector.
916-918 Gas & Electric Bldg.	
HARTFORD, Conn.,	F. H. Kenyon. General Agent.
56 Prospect St.	A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector.
Hibernia Bank Bldg.	E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y.,	C. C. Gardiner, Manager.
80 Maiden Lane	E. Mason Parry, Chief Inspector.
	R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	Bates, Lively & Pearson, Gen'l Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
415 Dexter-Horton Bldg.	
SAN FRANCISCO, Cal.,	H. R. Mann & Co., General Agents.
339-341 Sansome St.	J. B. Warner, Chief Inspector.
ST. LOUIS, Mo.,	C. D. Ashcroft, Manager.
319 North Fourth St.	Eugene Webb, Chief Inspector.
TORONTO, Canada,	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.
Federal Bldg.	

CARNEGIE LIBRARY
JUL 31 1925
PITTSBURGH, PENNA.

THE HARTFORD LINE

BOILER INSURANCE

Boilers, Economizers, Vulcanizers, Kiers, Digesters, Steam Driers, Jacketed Kettles, Etc.

FLYWHEEL INSURANCE

Flywheels, Fans, Blowers, Turbines, Water Wheels, Centrifugal Driers, Gear Wheels, Etc.

ENGINE INSURANCE

Engines, Compressors, Pumps, Refrigerating Machines, Etc.

ELECTRICAL MACHINERY INSURANCE

Generators, Motors, Synchronous Convertors, Transformers, Switchboards, Etc.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER
INSPECTION and INSURANCE CO.
HARTFORD CONNECTICUT

"The *oldest* in the Country, the *largest* in the world"

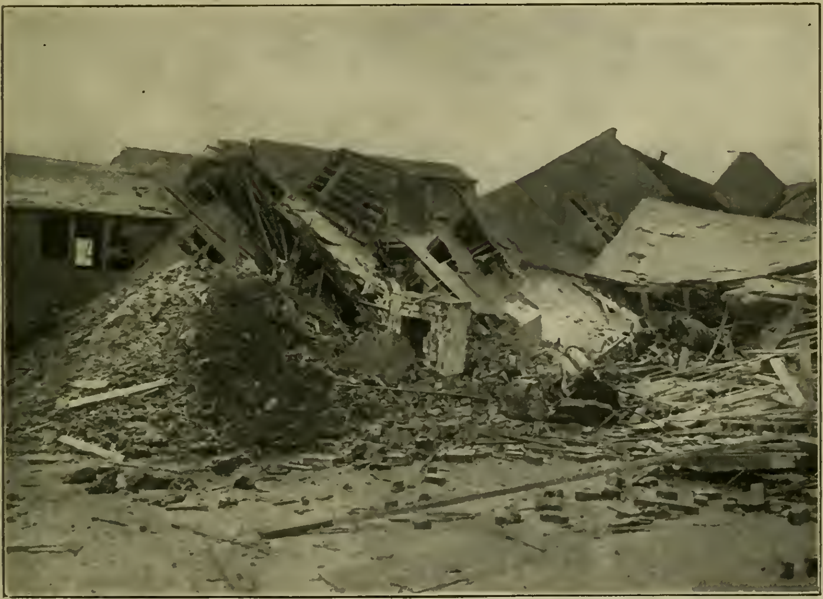
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

Vol. XXXV. HARTFORD, CONN., OCTOBER, 1925. No. 8.

COPYRIGHT, 1925, BY THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.



Boiler Explosion at Wolfeboro, N. H.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE
PLEASE LET HIM SEE IT.

Boiler Explosion at Wolfeboro, N. H.

AN explosion of considerable violence shook the town of Wolfeboro, New Hampshire, early in the morning of December 19, 1924, when the boiler in the laundry of Harry E. Libby exploded. The laundry was completely demolished including a 35 ft. brick stack, and general property damage in excess of $11,000 was sustained. A picture of the scene of the accident is shown on our front cover.

The boiler was of the locomotive wet bottom type with ¼ inch shell plates, 18 ft. 6 inches long and 40 inches in diameter of barrel. It was a two course boiler and the longitudinal seams were of the lap joint type and located on the bottom of the boiler. A Dutch oven was connected to the fire-box so that wood waste which comprised a large part of the fuel could be economically burned.

It had been the custom at this plant to allow the fire to burn out every evening, no attempt being made to keep up steam pressure all night. However, all stop valves on the boiler were closed at night, the boiler being thus shut in, so that the water in it would be near the steaming point in the morning and thus reduce the time required to get up steam.

On the morning of the accident, the engineer arrived at 6 A. M. to get up steam in preparation for the day's run. He reported no pressure showing on the steam gauge and the water level standing at 2½ gauges. The fire was started with shavings and wood waste as usual, and soft coal later added. The pressure had risen to 80 lbs. when a noise as of leakage was heard under the barrel of the boiler. Investigation revealed steam and water leaking apparently from the throat sheet seam. The engineer decided to put out the fire with a hose and was reaching for it when the leakage increased to such an extent that he thought it best to get away from the boiler. He had just reached the door leading to an abandoned saw mill, which was being used as a fuel room, when the boiler let go. The engineer did not remember hearing the explosion but found himself imbedded in a pile of sawdust, fortunately uninjured.

The cause of the accident was a lap seam crack. The initial failure was in the crack and about 1 ft. from the throat sheet. The line of rupture followed the crack until within 4 inches of the girth seam in the barrel at which point it tore off through the solid plate to the longitudinal seam of the front course and followed this seam — which was also affected by a lap seam crack although not so pronounced — to the front head. These sheets then opened up from the bottom, separated from the firebox sheet, and were thrown forward over the front head literally inside out, remaining attached to the front head by a few rivets at the top. The boiler can be seen projecting up onto the roof to the left in the cover picture.

That no one was injured in the explosion is due to the early hour at which it occurred, as the employees of the laundry had not arrived for work.

Changing Over Coal Burning Boiler Furnaces for Oil Burning.

IN view of the many apparent advantages of burning oil under boilers compared to burning coal, it is not surprising that many coal burning plants are being changed over. Whether it is at the urge of the oil men or due to the natural desire of the concern matters not, for the advantages of better furnace efficiency, cleanliness, flexibility, ease of handling and storing fuel are very real and have no corresponding disadvantages to be weighed against them. In some localities the storage problem is acute due primarily to regulations governing safety, but the one real drawback to the use of oil is the matter of price. At the time of installing the oil burners, a satisfactory price is undoubtedly available but how long it will so continue is problematical since the price of oil has not been stabilized as has that of coal. The price should remain within reasonable limits, however, until there is an actual shortage of oil, which, when it does occur, will be gradual and will not arrive unannounced. There are so many producing fields that the failure of a great number of them would be necessary to create a shortage. When the known resources are found to be failing, the hour of real shortage undoubtedly will be warded off by " wild catting " operations such as resulted in the discovery of the Smackover field. The original well in that field is said to have been drilled by a prospector who was disappointed in being unable to secure a lease in a known field nearby. There was no geological nor other indication of the probable presence of oil, but the prospector drilled, on a chance, and revealed a fertile field.

AMPLE FURNACE VOLUME NECESSARY.

In planning the installation of oil burning equipment, the principle considerations to be borne in mind are furnace volume, air supply and distribution, and guarding of the flame from impingement on the walls or heating surface.

For satisfactory results from burning oil under a boiler, ample furnace volume is necessary. In burning coal, part of the fuel is supported on the grate during combustion, but with oil the fuel is atomized into the air and burned in suspension; much as a gas or the volatile matter from solid fuel. Just as a solid fuel high in volatile content requires a large combustion space and perhaps even a Dutch oven, so also oil must have a large furnace. A too small furnace will result in the chilling of the gasses by coming in contact with the heating surface before combustion is complete and consequent loss of fuel. The recommended volume to allow varies somewhat with different authorities but the average appears to be between 2 and 2½ cu. ft. per rated horse-power. One prominent boiler manufacturer recommends 2 cu. ft. per rated horse-power, while another gives 2 cu. ft. per horse-power at 150% rating as proper. This latter rating is also the standard for a western railroad that serves the oil country. In a recent paper before the American Society of Mechanical Engineers, Nathan E. Lewis states, "The present practice ranges from 0.15 cu. ft. of furnace volume per sq. ft. of heating surface (0.35 cu. ft. per lb. of oil burned) with steam atomizing burners for boilers of industrial plants to 0.5 cu. ft. of heating surface (0.5 cu. ft. per lb. of oil burned) with mechanical atomizing burners of the boilers of large central stations," or a range of from 1.5 to 5 cu. ft. per rated horsepower.

Few Changes Necessary.

In converting an existing plant it is usually desired to make as few changes as possible, and it may be that sufficient volume to meet the above requirements may be obtained without even removing the grates. If this can be done the grates are covered over with fire brick either tightly or else in checkerwork style depending upon the source of air supply, that is, whether air is to be supplied around the burner or through checkerwork in the bottom of the combustion chamber. With a horizontal tubular boiler and with some types of water tube boilers the top of the bridge wall should be removed so that it will not deflect the gases against the shell or tubes and also to give an expanding or diverging combustion chamber. A better arrangement is effected by the complete removal of the grates and bridge wall and the bricking over of the ash pit, leaving enough space below for an air duct and interstices in the brickwork if the air is to be furnished in this manner. In some cases, it may even be necessary to lower the floor of the ash pit and combustion chamber in order to secure the requisite volume. A rough rule that appears to give successful results with horizontal tubular boilers states that the burners should be placed a distance of one boiler diameter below the shell. This applies up to 5 ft. which may be taken as a maximum distance for this type of boiler.

The air supply with reference to both amount and manner of introduction is of primary importance. There are in general two methods of supplying air for combustion in oil furnaces, the one to be used depending upon the type of burner. All burners in which the oil is atomized mechanically, and some burners in which it is atomized by steam, are provided with air intakes around the burner, and the oil burns with a conical flame. These intakes are adjustable and are designed to supply the air in a manner to produce good combustion. Reference to the shape of the flame is not intended to convey the idea that complete combustion takes place at the burner, for the oil burns practically throughout the combustion chamber. In fact upon looking into the fire through peepholes provided in the setting, the flame should not be conspicuously of any definite shape, but rather of an appearance variously described as a soft rolling flame or luminous haze.

Air Supply Depends on Type of Burner.

The simplest type of burner and the one most usually found in commercial plants uses steam to atomize the fuel which is sprayed out and burns with a flat fan-shaped flame and obtains its air through the floor of the combustion chamber. With the grates and bridge wall removed the ashpit is bricked over leaving a low air duct at the bottom having access to the combustion space through brick checkerwork. The openings in the brickwork appear to vary in existing installations from ½ inch to as much as 2 inches. The total area of opening should be from 1½ to 3 sq. inches per rated horse-power. The variation in these values is dependent upon the draft available and the extent and pattern of the openings in the checkerwork which as a rule are not uniform over the whole floor. These openings ought not extend back over 6 ft. from the burner and should be limited to the area immediately below the projecting flame. Since the bricks are laid loosely, the exact pattern of the openings can be made a matter of experiment, slight changes frequently effecting considerable improvement in combustion.

The matter of draft needs particular attention during operation. The flue gases resulting from the combustion of oil are less in amount per horse-power than from coal, and as a rule are cooler, due probably to a lower velocity through the boiler. The flue and chimney passages provided for coal should therefore be ample. The draft however, is quite likely to be excessive except perhaps in some cases where the original design called for forced draft. Oil furnaces do not require nearly as much draft as coal burning primarily because the air is not drawn through a fuel bed. In addition the use of steam in burners for atomizing the oil improves the draft. Where plenty of draft is available the attendants will very likely use more than is necessary either through carelessness or because they believe that combustion conditions will be thereby materially improved. In a previous issue* mention is made of a case wherein the fuel oil comsumption in a certain plant had been mysteriously increasing until it had almost doubled itself, when investigation revealed that draft greatly in excess of requirements was being used. The instructions to the boiler room force gradually "wore off" and the draft had been continually increased until about ten barrels of oil per day were being wasted up the stack. When the draft requirements for a given installation have been determined it is well to make some permanent or semi-permanent restriction, such as partly blocking up the flue gas passage to the stack, in order to guard against such waste. A careless operator has an opportunity for much greater waste with an oil furnace than with a coal furnace. Flue gas analyses should therefore be made frequently and a watch kept upon the stack. As with coal, absolutely smokeless combustion does not always mean that good results are being obtained for it is usually brought about by a too liberal air supply, and of course a smoky condition is the reverse. A slight haze emerging from the stack shows that good results are being obtained in the furnace.

Location of Burners Important.

In placing the burners, care should be exercised to see that the flame does not impinge directly upon either the boiler or the furnace walls. When the flame strikes the boiler, trouble invariably results. Usually it takes the form of pitting or blistering or in gradual wasting away of the metal, and, in horizontal tubular and locomotive type boilers, in leaky seams and tubes. Because of the limited combustion space in the fire box type of boiler, trouble is often experienced with burned rivet and bolt heads and leaky tube ends. One boiler manufacturer specializing in locomotive boilers has issued instructions for his designers to reduce as far as possible the projection of all bolt and rivet heads subjected to the fire in oil fired boilers. As an instance of tube trouble, inspection of one fire box boiler revealed every tube end in the firebox welded. This was done after changing over from coal because it was impossible to keep the tubes tight.

It has been suggested that the wasting of the metal might be due to erosion from impact of particles of unburned oil or else the blow-pipe action of the flame, but it is more likely due to the intensely high temperature of the flame concentrated upon a small area. The presence of scale accelerates the action. A thin scale that would not be considered serious in a coal burning installation might be serious in a boiler over an oil burning furnace in which the heat is localized. At a recent meeting of the American Society of Mechanical Engineers it was brought out during a discussion of this subject that investigation of several plants which had reported trouble after changing over to oil revealed that the work required of the boilers had been increased without a corresponding increase in feed water treatment. Hence scale accumulated more rapidly.

---

*The Locomotive, January 1920, p. 13.

When the flame impinges upon the wall or any part of the furnace it will rapidly disintegrate the lining. One of the requirements for good combustion of oil is that the furnace be maintained at a high temperature. This requires a large area of brickwork radiating its heat back to the fire. The temperature in an oil furnace is in the neighborhood of 3000° Fahrenheit, or from 300 to 500° higher than with coal. One of the big problems therefore is to get a refractory lining that will stand this temperature, and so when the flame of the burner is projected upon it the life of the lining is shortened.

Flame Should Not Be Obstructed.

It has also been found that if the flame meets any obstacle it will be deflected, usually against the boiler shell or tubes, resulting in trouble such as when the flame impinges directly upon the boiler as considered above. Furnaces designed to burn either oil or coal have been known to give trouble through the deflection of the flame by some unevenness in the ash bed left from the coal. Hence, when the grates are removed, the bridge wall should also be torn out, and where the grates are left intact and merely bricked over, the removal of the top of the bridge wall is advisable. This also gives an expanding combustion chamber. It is recognized that the burners should project the flame in the direction in which the size of the combustion chamber is increasing, because of the increase in volume of the gases during combustion and because of the better mixing obtained in a large chamber. The floor in the forward part of the chamber is elevated in forming an air duct in the ash pit, and drops down to the normal floor level beyond the site of the bridgewall. In some water tube boilers, particularly those in which the tubes have considerable upward slope toward the front, this principal of the expanding combustion chamber is obtained by using "rearshot" burners installed in back and projecting the flame toward the front.

Internally fired boilers, in order to maintain the requisite high furnace temperature, require a refractory brick lining around the lower forward part of the furnace, or else a refractory retort built on the front, Dutch oven style, thus leaving the full length of the furnace as heating surface. A ring of firebrick is usually built around the rear end of such furnaces to protect the back furnace flange seam, and in the wet back type the rear sheet of the combustion chamber should be protected by a lining.

Lighting Boiler Fires.

The following material appeared in *The Record*, published by the Associated Oil Co., as a prize winning article on accident prevention, and is here reprinted from the *Northwestern Pacific Headlight.*— Editor.

WE often hear of...accidents to firemen, but with understanding and care they can be avoided. Here are suggestions as to the best method of doing the work in lighting the [oil] fire under a boiler:

First — Be sure your stack damper and draft door is open wide before the torch is lighted.

Second — See that there is no accumulation of oil in the firebox, which may be the result of a leaking valve in the oil line of one of the burners.

Third — Open the atomizer valve and allow the accumulated condensed steam to escape. When the steam flows freely from the burner, close the valve until only a small amount of steam flows from the burner.

Fourth — place the lighted torch in contact with the flow of steam and open the oil valve slowly until the flow from the burner is a brownish color. The mixture will then light. It is best to leave the torch in contact with the burner until the firebox becomes hot (usually one-half hour is sufficient time).

To increase the fire, open both valves slowly, but always open the oil valve a little ahead of the steam valve; otherwise, the steam would have a tendency to blow the fire off the burner. Do not put a large fire under the boiler until the firebox is hot. Leave the draft well open until the water begins to boil. Your oil must be kept at a proper temperature at all times. Follow these instructions and you will have no serious back-fires.

Stresses In Flat Plates.

IN tank and plate metal construction it is very often necessary to use flat plates subject to a considerable stress due to a loading caused by a head of water. Such cases occur in flat bottoms of tanks placed on grillages, side walls of rectangular tanks, and water tight partitions carrying a water load on one side.

If the plates are supported on two parallel edges only, the computation of the stress is a comparatively simple matter. The ends being riveted and the plate being continuous over a number of supports, the beam formula applicable to a beam with fixed ends is used, and the moment coefficient is 1/12.

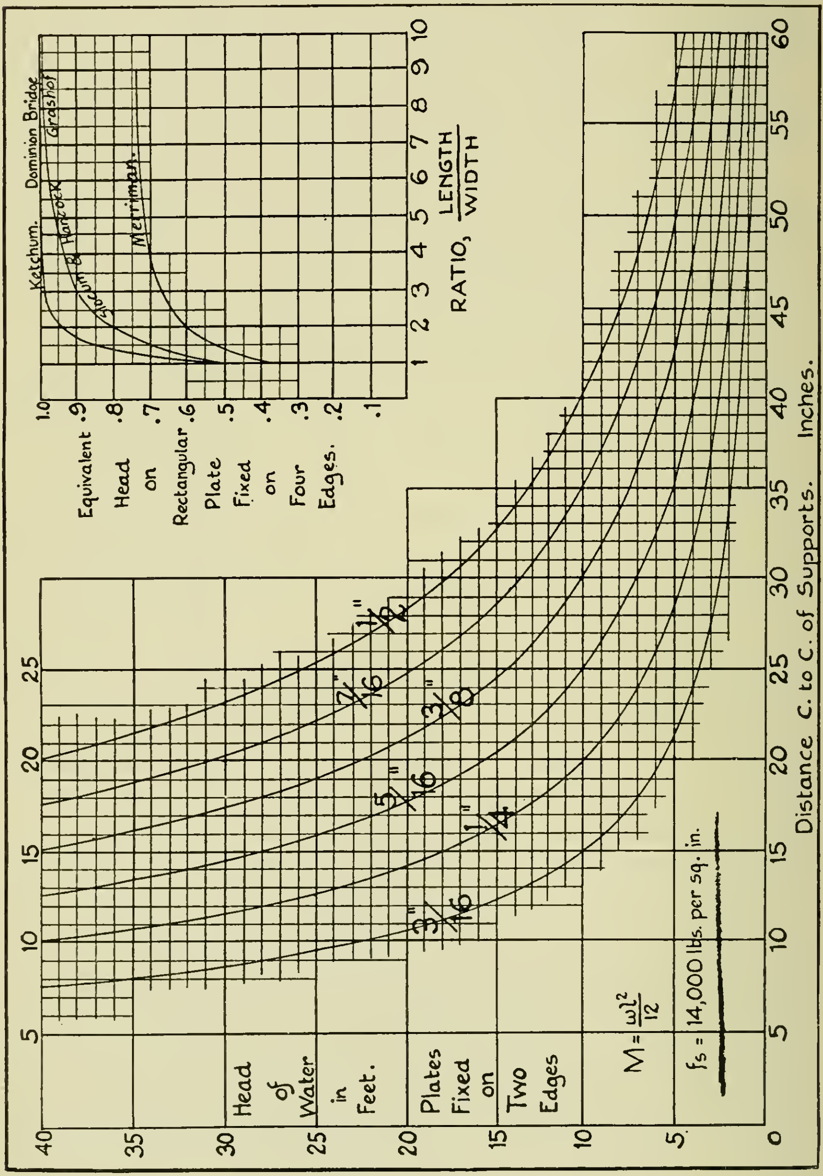
TABLE SHOWING DENSITIES OF VARIOUS LIQUIDS.

Liquid	*Weight (lbs.) per cu. ft.*
Oil — Mexican*	58-62
Texas	57-60
middle west	56-58
eastern	54-57
Molasses	92
Pitch	69
Tar	75
Asphaltum	81
Acid — muriatic	75
nitric	88-94
sulphuric	112-115
Alcohol	49-58

The larger part of the accompanying diagram is a graphical solution of this problem for various thicknesses of plate, based on a unit stress of 14,000 pounds per square inch. Let us suppose we have a tank 15 feet in height with a flat bottom ⅜ inches thick. The tank is to be supported on beams in a building and we want to know how close together the beams should be spaced. From the diagram we follow the 15 foot line across until it intersects the ⅜″ curve and then from the lower margin we see that the spacing should be 24½ inches. In the same way the plate thickness may be determined if the spacing is known.

---

*Some Mexican oils are very much heavier than given in this table.


Head of Water in Feet.
Plates Fixed on Two Edges.
$M = \frac{\omega l^2}{12}$
f_s = 14,000 lbs. per sq. in.
3/16"
1/4"
5/16"
3/8"
7/16"
1/2"
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance C. to C. of Supports. Inches.
Equivalent Head on Rectangular Plate Fixed on Four Edges.
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
1
2
3
4
5
6
7
8
9
10
RATIO, LENGTH/WIDTH
Ketchum.
Dominion Bridge
Grashof
Slocum & Hancock
Merriman.

If a plate is supported on four edges an exact determination of the stress is impossible and an approximate formula is used. Three of these formulae taken from five different sources and the results they give are illustrated in the upper right hand corner of the diagram. If a plate is fixed on four edges and its length is twice as great as its breadth, it is seen that the stress is from 0.6 to 0.94 times the stress if fixed on two long sides only.

Let us take, for example, the case of a rectangular tank 12 feet deep and nine feet square. It is desired to find the necessary plate thickness for the lower part of the side wall. We may divide the tank up into three panels in width by means of two vertical supports or stiffeners, and three panels in height by means of two horizontal supports. The dimensions of a panel are then three feet wide by four feet high and the average head on a lower panel is ten feet. The ratio of length to width is 1.33. From the middle curve of the upper diagram we see that our head may be reduced to 0.67 of what we would figure if the plate were supported on two opposite edges only, or 6.7 feet. From the lower diagram we see that with a head of 6.7 feet and a spacing of 36″ our plate should be ⅜″ thick. It is assumed that the four edges are firmly riveted to members capable of taking the bending.

If the allowable unit stress is to be increased, the head should be decreased in the same ratio. For example: If we desire to use 20,000 pounds per square inch instead of 14,000 we may use 0.7 of the head shown on the diagram. In certain classes of construction, notably condensor boxes for oil refineries, the unit stresses used are very high, and very often cause buckling of the plate. This may not lead to failure, however, as the plate would no longer take straight bending, but would take a combination of bending and direct tension and our diagram would not hold good.

In the case of the plate fixed on four edges we have considerable leeway if we attempt to follow the upper diagram. Of the three curves shown, the middle one appears to be the most reasonable, although tests made by J. Montgomerie (*Engineering*, London, June 13, 1919) would indicate that the actual plate stress is about sixty per cent of the stress given by the formula from which the curve is plotted. — *The Water Tower.*

Purchaser — " What is the charge for this battery? "
Garageman — " One and one-half volts."
Purchaser — " How much is that in American money? "

— *The Forg*

Steam Turbine Accident At Pittsfield, Massachusetts.

IT is often claimed that a turbine which is direct connected to a centrifugal pump or blower is in no danger of serious overspeed and so an emergency stop mechanism is not essential. The theory on which this claim is based is that with such apparatus there is always a load on the machine and, in case of a tendency to overspeed, the torque increases so rapidly that, although there may be a little increase in speed, there is no danger of a so-called runaway and a resulting explosion. One point that seems to be generally overlooked is that the rotor vanes of a blower may distort and break either by increased pressure or centrifugal force when the speed increases. This has actually been observed in a few cases. An accident of recent occurrence, moreover, seems to discredit the above theory, inasmuch as the evidence points to the initial failure of the turbine from overspeed and subsequent wrecking of the pump.

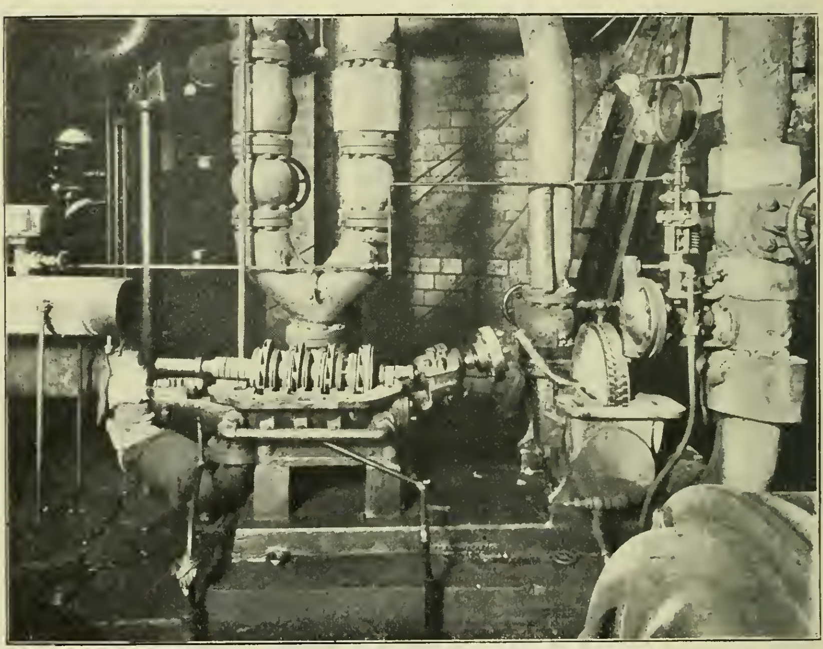


Fig. 1.

On June 12, 1925, a 60 horse-power turbine exploded in the plant of the Pittsfield Electric Co., Pittsfield, Mass. The turbine was direct connected to a boiler feed pump and operated at 2800 r.p.m. The governor, of the usual revolving weight type, was located on the end of the shaft. The evidence indicates that some part of the governor failed first and thus prevented the governor from functioning properly, finally disrupting it. With no counteracting force, the governor spring immediately opened the regulating valve and allowed the turbine to speed to destruction.

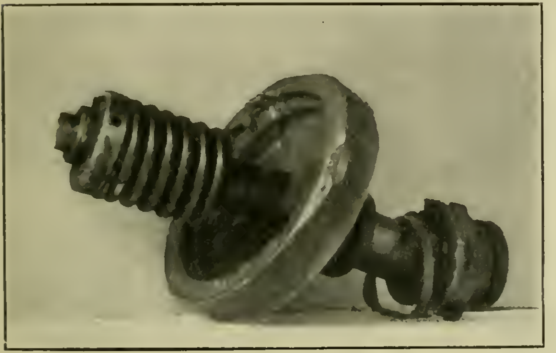


Fig. 2.

Figure 1 shows how the unit looked after the accident when the debris had been cleared away and the rotor replaced in the casing. The governor end of the shaft, shown in Fig. 2, broke off just beyond the bearing, and the other end of the turbine shaft was bent to an angle of approximately 45 degrees. Both bearings, which had been cast integral with the casing, were broken off, the top half of the casing shattered, and the nozzles torn out of the lower half of the casing. In fact, the turbine was completely wrecked. In addition the flexible coupling burst and considerable damage was also done to the pump, including the bending of the shaft.

This accident would very likely have been avoided or at least the damage would have been very slight had there been an emergency stop mechanism.

A Steam Pipe Explosion.

PRESSURE-CONTAINERS (boilers, tanks, and pipes) that are on the point of failure often give evidences of it which are visible to trained eyes, or which can be detected in other ways by expert engineers or inspectors. When these "symptoms" are discovered it is sometimes possible to make satisfactory repairs that will insure safety, at least temporarily; and if repairs are not practicable, the warning that has been received makes timely replacement possible.

It speaks well for the methods and materials used by pipe manufacturers, that pipe failures do not occur oftener. The manufacture of pipe is not an exact science, however, and once in a while a length which has withstood the pressure-test that is universally applied by the makers, and has been installed in the belief that it is of the usual good quality and strength, has failed under operating conditions, where the pressure has been materially less. Subsequent examination almost always shows a defect of some kind in the workmanship or material. There may have been no visible evidence that failure was imminent; and even if there had been it is quite possible that it would have remained undetected through being concealed by the heat-insulating covering with which the pipe was surrounded as soon as installed.

A short time ago a section of a steam pipe 8 inches in diameter burst and severely injured the engineer of the plant and one of the firemen and considerable property damage was done. The pipe had been in use for about two years, and there had been no advance indication of weakness.

The accident occurred at about 1 o'clock P. M. The by-pass of the throttle-valve had been opened, the engine was turning over slowly, and the engineer was about to open the main throttle-valve, when the pipe suddenly burst. As far as we have been able to learn, the failure of the pipe is attributed to a poorly made seam.

In another case, a dangerous condition was discovered in a large electric-power station, when two bolts failed in a flanged joint on one of the main steam pipes. These bolts were replaced by new ones but in attempting to tighten up the rest of the old bolts, two of them failed. One of the remaining bolts that had not failed was then tested by striking it with a hammer, under which it broke into several pieces. This led to further investigation, and the testing of other bolts in this joint and of some of the bolts in other similar joints about the station. In many cases it was found that the metal in the bolts was badly deteriorated, or "fatigued." As a result, orders were given to renew the bolts in the joints of all steam pipes in the plant that were four inches in diameter or larger — a proceeding which was expensive, but which was considered necessary to insure the station against a similar accident.

An experience of this kind shows the importance of constant supervision, and of the careful inspection of all possible danger-sources in power plants. Some of the hazardous conditions may be of such a nature that it will be impossible to discover them by any practicable method; but in case of accident it will be a source of satisfaction to realize that everything possible was done to detect them.

The moral is, inspect your steam line regularly. — *Universal Engineer.*

Another Autogenously Welded Tank Failure.

THE explosion of an autogenously welded storage tank, that resulted in the death of two men and from which several others narrowly escaped injury, recently came to our attention and was attended by several features that make it a valuable case to record.

The tank was 60 inches in diameter by 7 ft. long, with 3/16 inch shell and ¼ inch heads. It was of welded construction throughout, the electric arc method having been used. The material was tank steel, as the vessel was intended to be used merely for oil storage. The specifications, however, required that it should be air-tight at 15 lbs. pressure, and it was while being tested for fulfillment of this requirement that the accident occurred. The two men who were killed were working upon the tank at the time.

The tank was in a horizontal position on the ground, with the longitudinal seam about half way between the top and side, so that it was in full view. Compressed air was being received from a main carrying 90 lbs. pressure, but the pressure on the tank was regulated by a stop valve and a safety valve of ample proportions. Tests of the safety valve immediately after the explosion showed that it released at 15 lbs. pressure, so that the possibility that the explosion was due to over-pressure is removed.

It was felt that the strength of this class of tanks was ample for the use to which they were to be put, and the air-pressure test was merely for tightness, for which purpose testing by air is the regular practice in many boiler shops. Subsequent examination of the longitudinal weld, however, revealed a portion that was poorly welded, representing more than one third of the total length. It was apparently this portion that failed first, as indicated by an outward distortion of the shell. The longitudinal seam separated along its full length, and the shell then unwound from the heads and opened out almost flat. A portion of both head girth seams at the underside of the tank remained intact, and so retained the heads in their vertical positions. The tank barely moved from its original location, showing that the explosion was no more violent than would be expected at the limited pressure. As previously stated, the two men killed were working upon the tank.

This accident again emphasizes the unreliability of autogenously welded joints for pressure vessels; and it shows also the inadvisability of testing new vessels by air pressure, even at as low a pressure as 15 lbs. A riveted joint may be inspected and reasonable assurance of its soundness thereby obtained. Not so, however, with a welded joint, as the external appearance does not give a true indication of its soundness. Furthermore, the risks incurred in testing such vessels by air pressure are great. Testing implies that an occasional failure is to be encountered, else there would be no need of testing. The failure of a tank under air pressure, however, is invariably a matter of considerable violence. In this case, as in many others, the hazard was increased by caulking the leaks while under pressure.

The Opening of The Heating Season.

OCTOBER 1st is generally regarded as the opening of the heating season and is usually marked by several of that "didn't know it was loaded" type of explosions. Many heating installations have a duplex arrangement whereby one system is used during the winter while another is depended upon for light heating just before and after the regular heating season — central station heating, for instance, during the regular season and a local boiler called upon as necessary at other times. Or perhaps the amount of heat desired is governed by varying the number of boilers. At any rate the arrangements are such that frequently one or more boilers can readily be isolated by merely operating a valve or two. With such an arrangement of valves a fire mightly easily be started under an isolated boiler by someone not acquainted with the proper manipulation of the valves, and an explosion would certainly result unless the boiler were provided with an adequate relief or safety valve in freely operating condition.

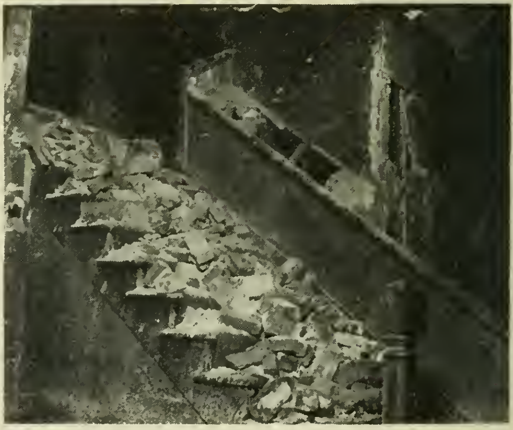


FIG. 1.

The City National Bank of Holyoke, Mass., marked October 1, 1924, by a slight variation of the above procedure. A small boiler was used during the summer for heating the hot water supply for the building. Upon starting up the horizontal return tubular boiler used for heating the building, the small boiler was cut out, the domestic hot water supply being heated by a trombone coil in the furnace of the larger boiler. However, the fire under the cast iron boiler had not entirely gone out, as was supposed, and, in the absence of a relief valve, the boiler was shattered.

As far as we are able to learn, no insurance was carried on this installation.

On June 12, 1925, a similar accident occurred at the Irving Hotel, Los Angeles, California, when a small steel plate heater used for heating the domestic hot water supply exploded. The heater was 21 inches wide, 36 inches high, and 30 inches long, and was of welded construction throughout. It was equipped with a ½ inch non-code safety valve set to relieve at 100 lbs. pressure and tests indicate that the valve was in good operating condition.

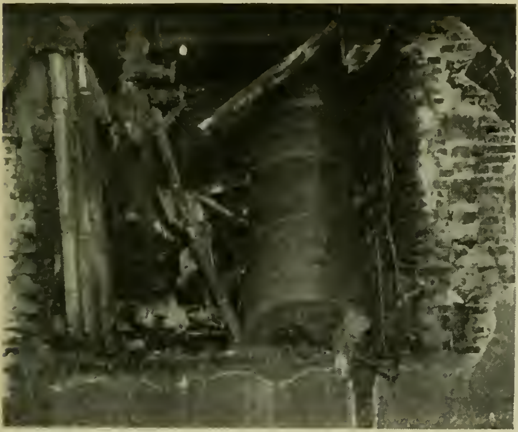


Fig. 2.

The explosion was brought about by the closing of stop valves in both the hot and cold water lines. Just why the valves were closed at this time is not clear, nor is it known what pressure was attained just prior to the accident, but the explosion was very violent as shown by the pictures.

The hotel was on the side of a hill and the boiler room was on the uphill side and on the second story level. The head of the boiler was projected through a brick wall and out into the lobby, landing about twenty feet from the original location of the heater. Fig. 1 is a view looking up the stairs from the lobby. Fig. 2 is a view from the head of the stairs looking through the hole in the wall into the boiler room. Considerable damage also was done to the floor above.

In Retrospect

"What have you been doing all summer?"
"I had a position in my father's office. And you?"
"I wasn't working, either."

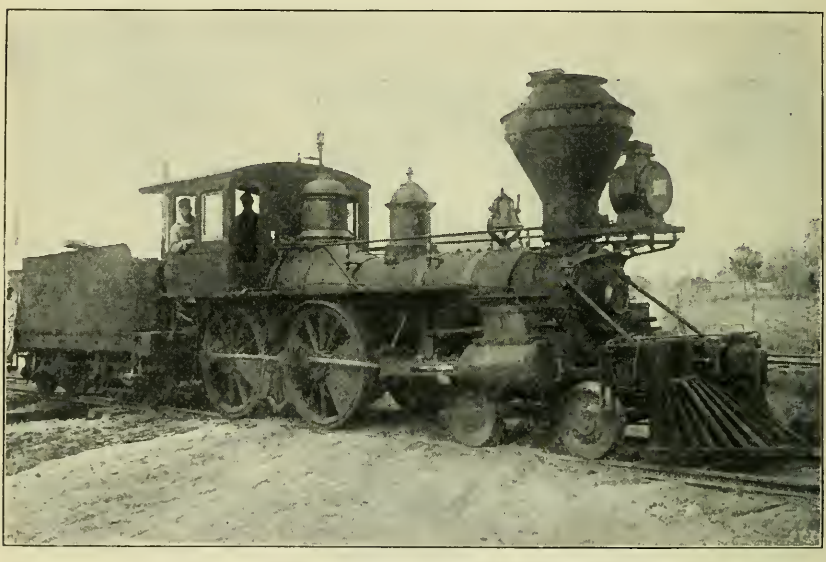
—*Rochester Gas & Electric News.*

Ancient Locomotive Still In Service.

A VETERAN locomotive truly deserving the name is in daily operation in logging service at the saw mill of J. N. Bray & Co., Valdosta, Ga. It was built in 1856, sixty-nine years ago, and still bears the original name plate on the front with the inscription —

M. W. BALDWIN, PHILADELPHIA, 1856.

The early history of this engine is apparently lost. The present owners purchased it as a second hand locomotive about 43 years ago, but all records of the sale have become lost so that any previous owners are unknown. The present owners state that it has been in their possession so long that it is regarded with much the same affection as an old family horse. It has been operated by over 100 persons, including all of the women of this family. Several efforts to purchase it have therefore been unsuccessful.



Photograph by Courtesy of The Baldwin Locomotive Works.

ANCIENT LOCOMOTIVE STILL IN SERVICE.

The cylinders on this engine are 12 inches in diameter by 22 inches stroke. The driving wheels are 54 inches in diameter. The original crank pins, rods, straps and keys are apparently still in use. The left front cylinder head has been replaced but the right cylinder is intact and the pistons are said to be the original ones placed in the engine when it was built.

The boiler is 36 inches in diameter by 15 ft. 6 inches long. It is jacketed with brass, as are also the steam chests. Patches and replacements have been made around the firebox, but the crown sheet is believed to be the original one. There is no record or indication of any repairs ever having been made to the barrel.

In 1923 this locomotive was engaged for a time in hauling logs on a short main line and consequently had to pass an Interstate Commerce Commission inspection. Accordingly it was given a hydrostatic test and approved for operation at 120 lbs. pressure, and the safety valve is now set for 120 lbs.

This veteran is said to be a sister engine to the famous locomotive "General," and a comparison of pictures of the two seems to bear this out. The "General" is the Western and Atlantic Railroad Co. engine that was captured and recaptured in an unsuccessful Federal raid near Big Shanty, Georgia. The "General" is now on permanent exhibition in the Union Depot at Chattanooga, a bit of military adventure having won for it retirement, whereas old Number 2 must labor on.

Caught in the Separator.

A Little Scotch.

Sandy was seen coming out of the First National Bank by his friend, MacGregor, and he was accosted thus by him:

"Been putting some money in the bank, hae ye, Sandy, I ken?"

"Nae, nae, no putting money in," answered Sandy.

"Well, it cannot be that ye were taking any out?" said MacGregor.

"Nae, nae, I was just in the place filling my fountain pen."

— *Exchange.*

Only a Dream.

Johnson was awakened the other night to find his wife weeping uncontrollably.

"My darling," he exclaimed, "what is the matter?"

"A dream," she gasped. "I've had such a horrible dream. I thought I was walking down the street and I came to a warehouse where there was a large notice 'Husbands for Sale!' You could get beautiful ones for $300, or even for $100, and very nice looking ones for as little as $50."

Johnson asked, innocently, "Did you see any that looked like me?"

The sobs became strangling. "Dozens of them," gasped the wife, "done up in bunches like asparagus and sold for ten cents a bunch."

— *Exchange.*

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, OCTOBER, 1925.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. Co.

A PENNY saved is not appreciated nearly so much as an additional penny of income. A catastrophe averted is not as impressive as one that occurs. Two striking instances will illustrate.

The inner shell of a jacketed rendering tank appeared to be getting thin but permission to test by drilling could not be obtained because " it might be found too thin for safe operation and we cannot spare it at the present time." As the inspector was sincere in his deductions and the owner firm in his refusal to allow the shell to be drilled, insurance on the vessel was canceled. Six months later it collapsed.

An order was placed for insurance on an engine. The initial inspection showed that the frame was broken. Repairs had been made but they were not considered adequate to make the engine reasonably safe, and additional repairs would not be considered, so insurance was not granted. According to a recent newspaper item, this engine is now a wreck. One man was killed in the accident.

It is safe to say in each of the above cases that the possibility of an accident was considered remote. The diagnosis of an expert was discounted. The value of inspections is incalculable.

OBITUARY.

Joseph McMurray.

JOSEPH McMURRAY, special agent in our New York Department, and for over fifty-three years an employee of this Company, died suddenly Tuesday, July 21, 1925 at his home in Albany, New York. He had been in good health but was taken acutely ill on Monday and died the following day.

Mr. McMurray was born in Brooklyn, N. Y. in April 1844. His early employment was in various steam engineering work at the Brooklyn Navy Yard. He came with this Company as an inspector in January, 1872, a few years after its organization, and in October, 1905 was appointed special agent. He has therefore been continuously employed by this Company for over fifty-three years, a noteworthy record which has not been excelled by any other employee. Two others have exceeded by a few years this record of affiliation with the Company but in each case the responsibility and burden of work had been lightened by retirement for a number of years before death. Efforts had been made from time to time to relieve Mr. McMurray of some of his most arduous duties, but without success as he insisted upon remaining on active duty in the field. It is of interest in this connection to recall the record of the late R. K. McMurray, brother of Joseph McMurray. For forty-three years he was chief inspector of our New York Department and remained active and retained full responsibility for the work until his death from pneumonia in 1910.

Mr. McMurray had a congenial personality and a faculty for making and holding friends, particularly with our assured, a characteristic that aided materially in developing the prestige and good will accorded our Company generally. By his death a real loss is sustained.

Charles F. Buchholz.

CHARLES F. BUCHHOLZ, special agent in our Philadelphia Department, died suddenly at his home in Palmyra, N. J. on Monday, July 6, 1925.

Mr. Buchholz was born in New York City April 7, 1871. He entered the employ of this Company August 13, 1891 as a clerk in the Philadelphia Department, and in February, 1906 was appointed a special agent. His service with the Company therefore extends over a period of thirty-four years. He is remembered by his associates as a good natured and congenial companion; he was a persistent and untiring worker, enthusiastic and happy about his work.

Mr. Buchholz was interested in civic and religious activities of the community in which he lived. At the time of his death he was serving his second term in the borough council of Palmyra and was treasurer of the First Lutheran Church, of which he was one of the founders.

Taken off in the prime of life, Mr. Buchholz had led a well rounded life and his loss will be keenly felt by those he served.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF NOVEMBER, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
619	15	Section of heating boiler cracked			B. Raffel	Loft Bldg.	New York, N. Y.
620		Section of heating boiler cracked			Hirschorn Realty Co.	Bag Factory	New York, N. Y.
621	16	Section of heating boiler cracked			City of Dyersburg	City Hall	Dyersburg, Tenn.
622		Section of heating boiler cracked			Herber J. Grant	Church	Independence, Mo.
623	17	Hot water heater exploded			Grant School	School	Pittsburgh, Pa.
624		Section of heating boiler cracked			Raymond Neiditz	Residence	Hartford, Conn.
625		Section of heating boiler cracked			City of Newton	School	W. Newton, Mass
626	17	Four sections heating boiler cracked			Old Colony Products Co.	Garage & Storage	Fall River, Mass.
627	18	Section of heating boiler cracked			W. E. Wright Co.	Builder's Supplies	Akron, Ohio
628		Six sections heating boiler cracked			Los Angeles Industrial Clinic and Hospital	Hospital	Los Angeles, Cal.
629		Six sections heating boiler cracked			Thomas Martindale	Garage	Philadelphia, Pa.
630		Five sections heating boiler cracked			Dumont Paint Co.	Paint Factory	Jamaica, L.I., N.Y.
631	19	Section of heating boiler cracked			The Windle Co.	Hotel	Jacksonville, Fla.
632		Section of heating boiler cracked			Kaufman Brodner	Glazier	New Haven, Conn
633		Boiler bulged and ruptured			U. S. Encaustic Tile Co.	Tile Plant	Indianapolis, Ind.
634		Tube ruptured			Est. of H. W. Oliver	Power Plant	Pittsburgh, Pa.
635	20	Section of heating boiler cracked			Conron Bros. Co., Inc.	Market & Storage Plant	New York, N. Y.
636		Section of heating boiler cracked			Consolidated Ind. School Dist.	School	Larrabee, Iowa
637		Three sections heating boiler cracked			Windsor Ave. Cong. Church	Church	Hartford, Conn.
638		Boiler ruptured			National Pottery Co.	Pottery Plant	Roseville, Ohio
639		Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
640	21	Boiler exploded		2	Baltimore & Ohio R. R. Co.	Railroad	Furman, Ill.
641		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
642	22	Five sections heating boiler cracked			Hatheway & Steane, Inc.	Warehouse	Hartford, Conn.
643		Two sections heating boiler cracked			M. H. Scanlan	Apartment House	Denver, Colo.
644		Non-return valve ruptured			New York Mills Corp'n	Textile Mill	N. Y. Mills, N. Y.
645	23	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.

MONTH OF NOVEMBER, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
646		Two headers cracked			Spreckels Sugar Co.	Sugar Factory	San Francisco, Cal.
647		Section of heating boiler cracked			Chas. Woodmansee Estate	Confectioners	Ogden, Utah
648	24	Eight sections heating boiler cracked			B. P. O. E. No. 144	Club Rooms	Owensboro, Ky.
649		Boiler exploded	1	1	Levy Hollway	Ranch	Cedar Hill, N. M.
650	25	Boiler exploded			Keokuk Nickel Plating Co.	Nickel Plating	Keokuk, Ia.
651		Boiler ruptured			City of Chanute	Power Plant	Chanute, Kansas
652		Two tubes ruptured			Schneider & Maguire	Cotton Gin	L. Providence, La.
653		Section of heating boiler cracked			Yellow Cab Co.	Garage	Chicago, Ill.
654		Section of heating boiler cracked			Mexia Indpt. School Dist.	School	Mexia, Texas
655		Section of heating boiler cracked			John S. Lingner	Apartments	St. Louis, Mo.
656		Five sections heating boiler cracked			Women's Home Mission Society	School	London, Ky.
657	26	Section of heating boiler cracked			Israel Ginsberg, Agent	Apartment House	Detroit, Mich.
658		Fitting on steam line ruptured			American Sea Grass Co.	Bed Factory	Brooklyn, N. Y.
659		Ammonia coil exploded	1		Brinins Tool Co.	Paint Factory	Los Angeles, Calif.
660	27	Boiler exploded		1	Phillips Mill	Sawmill	Carrabelle, Ga.
661		Boiler exploded	2	8	Dopson & Faucett	Sawmill	Thomasville, Ga.
662		Tube ruptured			Burlington Hosiery Mills	Hosiery Mill	Philadelphia, Pa.
663		Fourteen sections heating boiler cracked			Elks Club	Club House	Brooklyn, N. Y.
664		Two sections heating boiler cracked			Mayer & Schneider Enterprises	Theatre	New York, N. Y.
665	28	Seven sections heating boiler cracked (2nd accident)			Women's Home Mission Society	School	London, Ky.
666		Two sections heating boiler cracked			J. S. Gillispie	Theatre & Apts.	Kingsport, Tenn.
667		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
668		Steam separator exploded	1		State Museum	Museum	Denver, Colo.
669		Blow-off pipe falied			Solar Sturgis	Stamping Works	Elmhurst, Ill.
670	29	Tube ruptured			N. W. Bell Telephone Co.	Telephone Co.	Omaha, Neb.
671		Boiler exploded		1	Alta Vista Oil Co.	Oil Well	Coalinga, Cal.
672		All sections heating boiler cracked			Quincy Market Cold Storage and Warehouse Co.	Storage Plant	Boston, Mass.
673	30	Valve and flanges cracked			Union College, Inc.	College	College View, Neb.
674		Section of heating boiler cracked			Sagal & Slade	Apts. & Stores	New Haven, Conn.
675		Section of heating boiler cracked			Loew's, Inc.	Theatre	Brooklyn, N. Y.

MONTH OF DECEMBER, 1924.

676	1	Boiler exploded			Wilkinson Bldg.	Office Bldg.	Trenton, N. J.
677		Section of heating boiler cracked			Little Rock Cotton Exchange	Offices & Stores	Little Rock, Ark.
678		Five sections heating boiler cracked			Kuhlke Machine Co.	Machine Shop	Akron, O.
679	2	Three sections heating boiler cracked			Tonga Realty Corp'n	Off. & Loft Bldg.	New York, N. Y.
680		Six sections heating boiler cracked			City of Kingsport	School	Kingsport, Tenn.
681		Section of heating boiler cracked			Board of Education	School	N. Bergen, N. J.
682	3	Valve on main steam line ruptured			Jos. Hill & Co.	Greenhouse	Richmond, Ind.
683		Tube ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
684		Three sections heating boiler cracked			W. E. Wright & Co.	Builder's Supplies	Akron, Ohio
685		Section of heating boiler cracked			Florence G. McKeever	Off. & Loft Bldg.	New York, N. Y.
686	4	Hot water boiler exploded			Riverview Apartments	Apartment House	New York, N. Y.
687		Section of heating boiler cracked			H. V. Kell Co.	Wholesale Grocers	Griffin, Ga.
688		Section of heating boiler cracked			Madden-Atkinson Auto Co.	Auto Sales Station	Columbus, Ohio
689	5	Section of heating boiler cracked			Sisters of Mercy, Inc.	Home & Hospital	Oakland, Cal.
690	6	Section of hot water boiler cracked			Radcliffe College	College	Cambridge, Mass.
691		Section of heating boiler cracked			Board of Education	School	Bowling Green, Ky.
692	7	Tank exploded			American Velvet Co.	Textile Mill	Stonington, Conn.
693		Boiler ruptured	1			Apartment House	New York, N. Y.
694		Boiler exploded		1	Hooks and Bordages	Oil Well	Westlake, La.
695		Main steam line failed			National Biscuit Company	Paper Mill	Marseilles, Ill.
696		Fitting on main steam line failed	2		Buick Motor Co.	Automobile Fact'y	Flint, Mich.
697		Six sections heating boiler cracked			First Congregational Church	Church	Suffield, Conn.
698	8	Section of heating boiler cracked			Greensburg M. E. Church	Church	Greensburg, Pa.
690		Seven headers ruptured			Lockhart Iron & Steel Co.	Steel Plant	McKees Rocks, Pa.
700	9	Hot water heater exploded			T. A. Smith	Residence	Short Hills, N. J.
701		Boiler ruptured			Schwed Bros.	Office Bldg.	Elizabeth, N. J.
702		Handhole gasket blew out			New York Shipbuilding Corp'n	Shipyard	Camden, N. J.
703		Five sections heating boiler cracked			Emery H. Dorsey	Garage	Lima, Ohio
704	10	Section of heating boiler cracked			Levi Strauss & Co.	Dry Goods	San Francisco, Cal.
705		Steam pipe ruptured			Mobridge Electric Co.	Power Plant	Mobridge, S. D.
706	11	Section of heating boiler cracked			German Consol. Newspaper Co.	Publishing Plant	Cleveland, Ohio
707		Two sections heating boiler cracked			J. B. Nall & L. M. Neas	Office Bldg.	Kingsport, Tenn.
708		Three sections heating boiler cracked			Genesee National Bank	Bank	Buffalo, N. Y.
709		Three sections heating boiler cracked			County of Lincoln	Court House	Stanford, Ky.
710	13	Nine sections heating boiler cracked			E. J. Ridgway	Apartment House	Dayton, Ohio
711	14	Tube ruptured			Joseph Fahy's, Inc.		Sag Harbor, N. Y.

MONTH OF DECEMBER, 1924 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
712		Three sections heating boiler cracked			Thonet Bros., Inc.	Chair Factory	Brooklyn, N. Y.
713		Section of heating boiler cracked			St. Hedwigs Church	Church	Toledo, Ohio
714		Section of heating boiler cracked			MacGregor Garage, Inc.	Garage	Waltham, Mass.
715	15	Section of heating boiler cracked			Borris Bernstein	Apartment House	Brooklyn, N. Y.
716		Four sections heating boiler cracked			Costis Takis	Restaurant	New York, N. Y.
717		Two sections heating boiling cracked			Ironwood Amusement Corp'n	Theatre	Ironwood, Mich.
718		Three sections heating boiler cracked			Lavania B. Shallcross	Garage	St. Louis, Mo.
719	16	Seven headers cracked			White Plains Hospital	Hospital	White Plains, N.Y
720		Boiler bulged and ruptured			Lee Lumber Co.	Lumber Mill	Memphis, Tenn.
721	17	Boiler exploded			Pantorium Dyeing & Cleaning Co.	Cleaning Plant	Hoquiam, Wash.
722		Blow-off pipe fitting failed			City of Ackley	Power Plant	Ackley, Iowa
723	18	Air compressor exploded		2	State of Penna.	State Capitol	Harrisburg, Pa.
724		Fitting on steam line ruptured			Western Tablet & Stationery Co.	Stationery	St. Joseph, Mo.
725		Tube ruptured			St. Luke's Hospital	Hospital	San Francisco, Cal.
726		Section of heating boiler cracked			W. W. & C. A. Caldwell	Hotel & Stores	Concordia, Kansas
727	19	Section of heating boiler cracked			Industrial Lumber Co.	Lumber Mill	Elizabeth, La.
728		Section of heating boiler cracked			I. I. & M. M. Gray	Apartment House	San Francisco, Cal.
729		Crown sheet of locomotive collapsed			Johnson Porter Clay Co.	Clay Mine	McKenzie, Tenn.
730		Boiler bulged and ruptured			Wall Rogalsky Milling Co.	Mill & Elevator	McPherson, Kan.
731		Boiler exploded			Wolfeboro Laundry	Laundry	Wolfeboro, N. H.
732	20	Boiler exploded		1	Sequoyah Country Club	Country Club	Oakland, Cal.
733		Section of hot water boiler cracked			Radcliffe College	College	Cambridge, Mass.
734		Section of heating boiler cracked			The Arms Mfg. Co.	Leather Goods	Malden, Mass.
735	21	Four sections heating boiler cracked			Holy Family Church	Church	Erie, Pa.
73		Blow-off pipe fitting ruptured			Holton & Hunkel Greenhouse Co.	Greenhouse	Brown Deer, Wis.
737		Boiler exploded			Brown Paper Co.	Paper Mill	West Monroe, La.
738	22	Boiler exploded			W. A. Weaver	Sawmill	Earle, Ark.
739		Boiler exploded		4	Osage Railway Co.	Railroad	Shidler, Okla.
740		Four sections heating boiler cracked			Kuttnauer Apron Specialties Co.	Clothing Factory	Detroit, Mich.
741		Five sections heating boiler cracked			Iron Delft Theatre Co.	Theatre	Iron River, Mich.
742		Eight sections heating boiler cracked			St. Xavier's College	College	Louisville, Ky.
743		Section of heating boiler cracked			Waterfront Employers of Seattle	Labor Dispatching Office	Seattle, Wash.

744	23	Section of heating boiler cracked			A. M. & T. M. Hederman	Office Bldg.	Jackson, Miss.
745		Section of heating boiler cracked			Knights of Columbus	Lodge Room	Louisville, Ky.
746		Section of heating boiler cracked			Palmer & Stevens	Apartment House	San Francisco, Cal.
747		Two sections heating boiler cracked			United Motors Service	Auto Supplies	Chicago, Ill.
748		Boiler exploded		1	Great Northern R. R. Co.	Roundhouse	Cut Bank, Mont.
749	24	Crown sheet of locomotive ruptured			Bayside Redwood Co.	Logging	Eureka, Cal.
750		Boiler bulged and ruptured			City of Collinsville	Light Plant and Water Works	Collinsville, Okla.
751		Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
752		Tube ruptured	1	1	St. Margaret's Hospital	Hospital	Pittsburgh, Pa.
753		Three sections heating boiler cracked			C. T. Dearing Printing Co.	Printing Office	Louisville, Ky.
754		Two sections heating boiler cracked			Layrac & Elgorriago	Apartment House	San Francisco, Cal.
755	26	Section of heating boiler cracked			Carbon County School Dist.	School	Price, Utah
756		Two sections heating boiler cracked			School District	Public School	New Britain, Ct.
757		Six sections heating boiler cracked			R. H. Borders & H. Tutwiler, Trustees	Hotel	Birmingham, Ala.
758		Tube ruptured			Bucyrus Co.	Steam Shovels	Evansville, Ind.
759		Boiler exploded		1	Rio Bravo Oil Co.	Oil Well	Wortham, Texas
760		Ammonia pipe failed			Waycross Ice & Cold Storage Co.	Refrigerating Pt.	Waycross, Ga.
761	27	Vulcanizer exploded			Mahaney Service Station	Service Station	Waxahachie, Tex.
762		Section heating boiler cracked			Wappingers Falls R. R. Co.	Street Railway	Poughkeepsie, N.Y.
763		Section of heating boiler cracked			Chattanooga Golf & Country Club	Country Club	Chattanooga, Tenn.
764		Section of heating boiler cracked			A. & M. Stone	Stores	Chicago, Ill.
765		Five sections heating boiler cracked			The 12th Street Garage	Garage	Wheeling, W. Va
766		Six sections heating boiler cracked			Beatrice L. Wadman	Office Bldg.	N't'n Centre, Mass.
767	28	Two sections heating boiler cracked			D. & W. Roller	Restaurant	Kingsport, Tenn.
768		Five sections heating boiler cracked			Bob & Baskind	Shirt Factory	St. Clair, Pa.
769	29	Four sections heating boiler cracked			County of Rockbridge	Court House	Lexington, Va.
770		Section of heating boiler cracked			Oakland Motor Car Co.	Automobile Fact'y	Gd. Rapids, Mich.
771		Section of heating boiler cracked			Ascher Bros.	Theatre	Chicago, Ill.
772		Section of heating boiler cracked			Main & Exchange Bldg., Co.	Offices & Stores	Akron, Ohio
773		Section of heating boiler cracked			Theodore F. Hagenow	Mercantile Bldg.	St. Louis, Mo.
774		Five tubes pulled out of drum			Western Cartridge Co.	Cartridge Fact'y	East Alton, Ill.
775		Crown sheet of locomotive failed			Whiteman-Decker Lumber Co.	Saw Mill	Farmersville, La.
776	30	Blow-off pipe failed			Curtis G. Wheeland	Laundry	Williamsport, Pa.
777		Boiler exploded			Minnie Hubble	Residence	N. Manchester, Ind.
778		Six sections heating boiler cracked			Gladstone Hotel	Hotel	Kansas City, Mo.
779		Section of heating boiler cracked			Indianapolis Paper Stock Co.	Paper Stock	Columbus, Ohio
780	31	Two sections heating boiler cracked			Estate of F. A. Poth	Office Bldg.	Philadelphia, Pa.

MONTH OF JANUARY, 1925.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	1	Section of heating boiler cracked			Consolidated School Dist.	School	Larrabee, Ia.
2		Section of heating boiler cracked			Deutscher Evangel Weisenhouse	Orphanage	Bensonville, Ill.
3		Six sections of heating boiler cracked			Board of Public Education	School	Pittsburgh, Pa.
4		Five sections of heating boiler cracked			M. Anderson & E. M. Ollman	Offices & Stores	Malden, Mass.
5		Boiler exploded		2	Simmons No. 7 Location	Oil Well	Wortham, Texas.
6		Boiler exploded			Daily News	Newspaper Office	Newton, Iowa.
7		Boiler of locomotive exploded	1	1	Pennsylvania R. R. Co.	Railroad	Bentleyville, Pa.
8	2	Four sections heating boiler cracked			Doubleday Hill Electric Co.	Elec. Supplies	Pittsburgh, Pa.
9		Section of heating boiler cracked			Sowers Mfg. Co.	Foundry	Buffalo, N. Y.
10		Manifold of heating boiler cracked			Howland-Hughes Co.	Mercantile Bldg.	Waterbury. Conn.
11		Blow-off pipe failed			Sterling Gasoline Corpn.	Refinery	Granville, W. Va.
12	3	Tube ruptured			Michigan Alkali Co.	Chemical Plant	Wyandotte, Mich.
13		Section of heating boiler cracked			Conron Bros.	Loft Bldg.	New York, N. Y.
14		Section of heating boiler cracked			Margaret L. Miller	Apt. House	Hartford, Conn.
15		Two sections heating boiler cracked			Hotel London	Hotel	London, Ky.
16	4	Two sections heating boiler cracked			Waldorf System, Inc.	Restaurant	Boston, Mass.
17	5	Section of heating boiler cracked			Vincenzo Calamia	Apt. House	St. Louis, Mo.
18		Two section heating boiler cracked			Olympia Theatres, Inc.	Theatre & Office	Boston, Mass.
19		Section of heating boiler cracked			Douglas & Simmons	Hardware	Richmond, Ky.
20		Three tubes ruptured			Univ. of Utah	University	Salt L. City, Utah
21	6	Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
22		Boiler exploded			Consolidated Lumber Co.	Lumber Mill	Cove Station, Pa.
23		Section of heating boiler cracked			South Side Lodge	Lodge Rooms	Patchogue, L. I.
24	7	Section of heating boiler cracked			Thompson-McIntosh Realty Co.	Offices & Stores	Las Animas, Colo.
25		Blow-off pipe failed			Wooster Brush Co.	Brush Factory	Wooster, Ohio.
26	8	Tube ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
27		Drier steam connection failed			Rock Island Brewing Co.	Brewery	Rock Island, Ill.
28		Vulcanizer exploded			Standard Service Station	Service Station	Merced, Calif.
29	9	Tube ruptured			City of Vandalia	Power Plant	Vandalia, Ill.
30		Boiler exploded	2	7	E. L. Smith Oil Co.	Oil Well	Wortham, Texas.
31		Section of heating boiler cracked			F. W. Burnham	Garage	Greenfield, Mass.
32	10	Section of heating boiler cracked			Board of Education	School	Shenandoah, Iowa.
33		Section of heating boiler cracked			City of Canton	School	Canton, Miss.

34		Section of heating boiler cracked			A. Rifkin	Apt. House	Denver, Colo.
35		Section of heating boiler cracked			Benj. Slade	Office Bldg.	Bridgeport, Conn.
36		Boiler exploded	1	2	Texas Company	Oil Well	Electra, Texas.
37	11	Two sections heating boiler cracked			C. E. Geannacopoulous	Theatre	Atlantic, Iowa.
38		Header cracked			Pittsburgh Terminal Warehouse & Transfer Co.	Term. Warehouse	Pittsburgh, Penna.
39		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Penna.
40	12	Section of heating boiler cracked			J. A. Cole	Hotel	Hiawatha, Kansas.
41		Four sections heating boiler cracked			Noble & Westbrook Co.	Stamp & Die Wks.	E. Hartford, Conn.
42	14	Fitting on main steam line ruptured			Max Rosenblatt		New York, N. Y.
43		Three sections heating boiler cracked			Bray Hotel Co.	Hotel	Kansas City, Mo.
44	15	Section of heating boiler cracked			Consolidated School Dist.	School	Larrabee, Ia.
45		Section of heating boiler cracked			City of Northampton	City Hall	North'pton, Mass.
46		Section of heating boiler cracked			City of Mishawaka	Power Plant	Mishawaka, Ind.
47		Section of heating boiler cracked			Board of Education	School	Alma, Michigan.
48		Two sections heating boiler cracked			Algona Hotel	Hotel	Algona, Iowa.
49		Boiler bulged and ruptured			J. C. Dunavent	Flour Mill	Eminence, Ky.
50		Tube ruptured			International Milling Co.	Flour Mill	Sioux City, Iowa.
51	16	Section of heating boiler cracked			Noble & Westbrook	Stamp & Die Wks.	E. Hartford, Conn.
52		Four sections heating boiler cracked			Bronx Plaza Theatre Corp.	Theatre	New York, N. Y.
53		Two sections heating boiler cracked			Sisters of St. Joseph	Convent & Hosp.	Wichita, Kansas
54	18	Three sections heating boiler cracked			J. & O. Constantine	Stores	Tulsa, Oklahoma.
55		Seven sections heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Glens Falls, N. Y.
56		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Penna.
57	19	Tube ruptured and four headers cracked			Mexican Petroleum Co.	Oil Plant	Carteret, N. J.
58		Four sections heating boiler cracked			State Normal School	School	Athens, Ga.
59		Section of heating boiler cracked			Air Reduction Co., Inc.	Oxygen Plant	Dorchester, Mass.
60		Section of heating boiler cracked			J. Tainsky	Residence	Brooklyn, N. Y.
61		Boiler exploded		1	Atlas Distillery	Distillery	Peoria, Ill.
62	20	Boiler bulged and ruptured			St. Jos. Coal Mining Co.	Coal Mine	Vibbard, Mo.
63		Section of heating boiler cracked			C. Wilens & Morris Aaron	Apartments	Hartford, Conn.
64		Three sections heating boiler cracked			First Church of Christ	Parish House	Hartford, Conn.
65		Section of heating boiler cracked			Second Church of Christ, Scientist	Church	Pittsburgh, Pa.
66	21	Economizer manifold failed			Amer. Steel & Wire Co.	Steel Plant	Waukegon, Ill.
67		Tube ruptured			Eastman Kodak Co.	Kodak Factory	Rochester, N. Y.
68		Ammonia pipe burst		2	San Antonio Packing Co.	Packing House	San Antonio, Tex.
69	22	Four sections heating boiler cracked			Alta Social Settlement	Community House	Cleveland, Ohio.
70		Section of heating boiler cracked			O'Bryan Bros.	Factory	Nashville, Tenn.
71		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1924

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$312,885.77
Real Estate	255,000.00
Mortgage and collateral loans	1,797,000.00
Bonds and stocks	9,830,809.50
Premiums in course of collection	1,114,552.34
Interest Accrued	145,614.56
Total assets	$13,455,862.17

LIABILITIES

Reserve for unearned premiums		$5,897,736.62
Reserve for losses		258,782.17
Reserve for taxes and other contingencies		559,988.34
Capital stock	$2,500,000.00	
Surplus over all liabilities	4,239,355.04	
Surplus to Policyholders,		**$6,739,355.04**
Total liabilites		$13,455,862.17

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
L. F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
S. F. JETER, Chief Engineer.
K. A. REED, Electrical Engineer.
H. E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

ATWOOD COLLINS, Hartford, Conn.
LUCIUS F. ROBINSON, Attorney, Hartford, Conn.
JOHN O. ENDERS, Chairman Board of Trustees United States Security Trust Co., Hartford, Conn.
MORGAN B. BRAINARD, President Ætna Life Insurance Co., Hartford, Conn.
CHARLES P. COOLEY, President Society for Savings, Hartford, Conn.
HORACE B. CHENEY, Cheney Brothers, Silk Manufacturers, South Manchester, Conn.
D. NEWTON BARNEY, Vice-President The Hartford Electric Light Co., Hartford, Conn.
DR. GEORGE C. F. WILLIAMS, President The Capewell Horse Nail Co., Hartford, Conn.
JOSEPH R. ENSIGN, President The Ensign-Bickford Co., Simsbury, Conn.
EDWARD MILLIGAN, President Phœnix Insurance Co., Hartford, Conn.
MORGAN G. BULKELEY, JR., Vice-President and Treasurer Ætna Life Ins. Co., Hartford, Conn.
CHARLES S. BLAKE, President The Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.
WM. R. C. CORSON, Vice-President The Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.
SAMUEL M. STONE, President The Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
SAMUEL FERGUSON, President The Hartford Electric Light Co., Hartford, Conn.

Incorporated 1866

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, Ga.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abell Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn.,	W. G. Lineburgh & Son, General Agents.
404-405 City Savings Bank Bldg.	A. E. Bonnet, Chief Inspector.
CHICAGO, Ill.,	P. M. Murray, Manager.
209 West Jackson B'l'v'd	J. P. Morrison, Chief Inspector.
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio,	W. E. Gleason, Manager.
First National Bank Bldg.	W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chesnutt, Manager and Chief Inspector.
916-918 Gas & Electric Bldg.	
HARTFORD, Conn.,	F. H. Kenyon, General Agent.
56 Prospect St.	A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector.
Hibernia Bank Bldg.	E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y.,	C. C. Gardiner, Manager.
80 Maiden Lane	E. Mason Parry, Chief Inspector.
	R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	Bates, Lively & Pearson, Gen'l Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
415 Dexter-Horton Bldg.	
SAN FRANCISCO, Cal.,	H. R. Mann & Co., General Agents.
339-341 Sansome St.	J. B. Warner, Chief Inspector.
ST. LOUIS, Mo.,	C. D. Ashcroft, Manager.
319 North Fourth St.	Eugene Webb, Chief Inspector.
TORONTO, Canada,	H. N. Roberts, President, The Boiler Inspection and Insurance Company of Canada.
Federal Bldg.	

CARNEGIE LIBRARY
OCT [illegible] 1925
OF PITTSBURGH, PENNA.

THE HARTFORD LINE

BOILER INSURANCE
Boilers, Economizers, Vulcanizers, Kiers, Digesters, Steam Driers, Jacketed Kettles, Etc.

FLYWHEEL INSURANCE
Flywheels, Fans, Blowers, Turbines, Water Wheels, Centrifugal Driers, Gear Wheels, Etc.

ENGINE INSURANCE
Engines, Compressors, Pumps, Refrigerating Machines, Etc.

ELECTRICAL MACHINERY INSURANCE
Generators, Motors, Synchronous Convertors, Transformers, Switchboards, Etc.

Consult your agent or broker or write for details to the nearest branch office of

THE HARTFORD STEAM BOILER INSPECTION and INSURANCE CO.
HARTFORD CONNECTICUT

"The *oldest* in the Country, the *largest* in the world"

CARNEGIE LIBRARY OF PITTSBURGH
3 1812 04248 1359